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Using Survivor Functions to Estimate Occupation-Specific Bonus Effects

Daniel F. Kohler

40 Years 1948-1988

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This study reports on the development of a new type of model for estimating the effect of reenlistment bonuses on retention in the armed forces. The new model, based on estimating a survivor function, presents two major improvements over the way in which bonus effects have traditionally been analyzed: (1) lag and lead effects of bonuses can be identified, and (2) bonus effects can be estimated for individual specialties. Past analyses of survivor functions were used to explain retention behavior over time for one specific cohort. In this report, the approach is modified to allow analysis of several cohorts simultaneously, and to permit differential influences of some variables, most notably reenlistment bonuses paid at the first expiration of term of service, on different segments of the survivor function. This study substantiates the finding that bonus-induced reenlistees have lower reenlistment rates at the second reenlistment point. It also shows, however, that the expectation of a bonus tends to reduce attrition toward the end of the first term, leading to more individuals reaching the first reenlistment point.

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PREFACE

Reenlistment bonuses are the major tool by which manpower planners in the military services attempt to influence the composition of the active force with respect to years of service. Bonuses are paid selectively in those specialties where there exists a shortfall of reenlistees and thus of second- and higher-term personnel. But although application of the reenlistment bonuses is specialty-specific, the improvement factors used in gauging their effects are not. The research reported here develops a methodology that allows estimating specialty-specific bonus improvement factors and demonstrates its feasibility by applying it to 15 specialties from all four services.

This report was prepared for the Office of the Assistant Secretary of Defense for Force Management and Personnel, which supported the research. The study was made in RAND's Defense Manpower Research Center. The Center is a component of RAND's National Defense Research Institute, an OSD-sponsored Federally Funded Research and Development Center. The findings should be of interest to persons concerned with allocating bonus budgets and with evaluating their effectiveness in achieving the stated objectives. The technical description of the theoretical work should also provide researchers with an opportunity to reassess currently used estimates of bonus improvement factors, and to consider potentially useful alternative approaches.

SUMMARY

This study reports on the development of a new type of model for estimating the effect of reenlistment bonuses on retention in the armed forces. The new model, based on estimating a survivor function, presents two major improvements over the way in which bonus effects have traditionally been analyzed:

- Lag and lead effects of bonuses can be identified
- Bonus effects can be estimated for individual specialties

Survivor functions have been used before to analyze retention in the armed services. In the past, however, these analyses were used to explain retention behavior over time for one specific cohort (e.g., everyone who enlisted in FY 1975). In this report, the approach is modified to allow analysis of several cohorts simultaneously, and to permit differential influences of some variables, most notably reenlistment bonuses paid at the first ETS (expiration of term of service), on different segments of the survivor function.

Some researchers, notably Warner and Simon [1979] and Rodney et al. [1980], have observed that individuals who received reenlistment bonuses at their first reenlistment point were less likely to reenlist at the second reenlistment point than were individuals who had not received bonuses. This implies that models which predict the additional man-years generated by a bonus increase at the first reenlistment point, based on bonus improvement factors estimated for the first reenlistment point and historical continuation rates in the other periods, are likely to overestimate the effectiveness of a bonus.

This study substantiates the finding that bonus-induced reenlistees have lower reenlistment rates at the second reenlistment point. It also shows, however, that the expectation of a bonus tends to reduce attrition toward the end of the first term, leading to more individuals reaching the first reenlistment point. Studies that use as the relevant population servicemen and servicewomen who have reached their first reenlistment point are unable to quantify this effect, and will thus tend to underestimate the bonus improvement factors. As far as the additional man-years generated are concerned, lag and lead effects work in opposite directions.

That the effects of bonuses vary among specialties has frequently been stipulated, and some empirical evidence exists to support this hypothesis. Rodney et al [1980], Warner and Goldberg [1984], and

Lakhani and Gilroy [1984] all observe considerable differences among groups of specialties in the responsiveness to bonuses as measured by bonus improvement factors or elasticities. However, estimating bonus effects for a single specialty is extremely difficult. Since bonuses are allocated by individual specialty, it follows that all servicemen within the same skill or specialty at the same time are offered the same bonus step. Any variation in actual bonus paid within a specialty at a given time is strictly a function of variations in base pay and length of reenlistment period chosen by reenlistees and thus can not be used for identifying response to bonus changes. The only way of resolving this difficulty is by combining different cohorts and estimating bonus effects based on the variation in bonuses over time.

This study adopts such a time-series approach, and extends it further. The data used consist not only of a time series of reenlistment periods, but also corresponding time series of periods before and after the reenlistment period. What is being analyzed is a time series of retention profiles.

This study's main aim was methodological. The empirical applications have therefore more the character of illustrations than exhaustive investigations. The estimation is necessarily confined to military occupations that have experienced some variation in reenlistment bonuses offered over the past decade, since the discontinuation of the selective service. Fifteen of them are analyzed, and the results reported here.

The net reduction in individuals leaving the service at the first reenlistment point due to a one-step increase in the bonus over the average observed during the past 10 years varies from virtually nil (.1 percent for air traffic controllers in the Air Force, AFSC 272×0) to 33 percent (artillery and gunnery in the Navy, rating GMG). For one-third of the specialties analyzed, this reduction exceeded 12 percent, and for one-third it was less than 5 percent. The increase in man-years generated varies similarly from .1 percent to 19.4 percent, with one-third above 6 percent and one-third below 2 percent. These estimates take lag and lead effects into account.

The survivor function approach as developed in this study does have its limitations. Most importantly, it can only be applied to those specialties which have historically had some variation in bonuses. At present, this is only true for a subset of specialties. The empirical estimation of these kinds of models also requires maximizing highly nonlinear likelihood functions with large numbers of parameters. The numerical algorithms to do this place very heavy demands on computing resources.

The kinds of results that can be obtained with the survivor function approach do warrant closer consideration. They show, among other things, that traditionally used estimates are suspect on several grounds, most notably the failure to properly consider lag and lead effects, and the tendency to lump specialties that might have substantially different bonus improvement factors into the same groups. As bonuses continue to play an important role in the services' manpower policies, serious consideration should be given to finding ways of expanding the specialties that are amenable to the kinds of analyses presented here. The most effective way of doing this would be through a bonus experiment.

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I. INTRODUCTION

THE PROBLEM

To function effectively at reasonable cost, the military depends on the continued service of a proportion of the enlisted personnel past the end of their first term of service. Second-termers offer a number of advantages over new recruits—they are more experienced, do not require all the costly initial training of new recruits, and generally have lower attrition rates. If given the choice, most military personnel managers would prefer having one more individual reenlist than one more new recruit enlist, provided that the grade structure can accommodate such growth, and the two individuals are otherwise comparable.

The selective reenlistment bonuses (SRBs) are the major tool by which the military services induce enlisted personnel to reenlist for a second term. As their name suggests, the SRBs are offered to servicemen in selected occupations, where it is feared that without this added inducement reenlistment rates would fall short of the desired objectives. The amount of the SRB offered to an individual is proportional to the monthly basic pay he or she receives. The factor of proportionality is calculated by multiplying the number of years for which the individual reenlists by the "bonus multiple," which is the same for every reenlistee within the same military occupation. The bonus multiple is adjusted over time in accordance with the service's personnel needs.

In making such adjustments, the bonus program managers in the different services attempt to balance the costs of the bonuses against the benefits of retaining additional servicemen and servicewomen. They attempt to allocate the bonuses to specialties that are most critical by the services' own standards. However, they also would like to direct bonuses toward those specialties where individuals are more likely to respond to this incentive.

To do this, bonus managers need to know three things: (i) the criticality of the specialty in question, i.e., the costs associated with falling short of the desired staffing in that specialty, (ii) the responsiveness of reenlistment rates with respect to changes in the SRB multiples, and (iii) the potential for substituting different personnel for the one in short supply. This report addresses only the second of these points, by developing a methodology for estimating the effects of bonus multiple changes on reenlistment and retention at the first ETS.[1]

As shall become obvious in the next subsection, this has been done before. However, the traditional methodologies for estimating reenlistment elasticities or SRB improvement factors[2] have serious shortcomings which the new methodology presented here can help overcome. For example, the traditional methods for evaluating the effectiveness of the SRB usually assume that its effect is confined to the reenlistment rate. By using a survivor function approach, it is possible to quantify lag and lead effects of bonuses, and investigate the effect of SRB changes on the entire retention profile of an individual, not just his or her propensity to reenlist at a specific point in time. In addition, the new methodology presented here is particularly well suited to derive occupation-specific bonus improvement factors, although some of the traditional methods were also able to provide some of this detailed information.

The purpose of this report is thus twofold: (i) to provide a new framework for analyzing bonus effects, paying particular attention to some effects that the traditional methods ignore, and (ii) to demonstrate that the framework can indeed be made operational. That the new framework has the potential to answer most of the questions the old methods were able to handle, plus a few quite important ones the old methods ignore, will become clear after Section II is compared with the brief literature review in the following subsection. That it can be made operational will be demonstrated by applying it to a sample of 15 military occupations or skills ("MOS" in the Army and the Marines, "Ratings" in the Navy, and "AFSC" in the Air Force).

Throughout the methodological development has taken precedence over the empirical implementation. It is important that the survivor function framework be developed as cleanly as possible, and that convenient assumptions that would simplify the empirical implementation be postponed as far as possible. The same principle has guided the selection and specification of explanatory variables other than bonus step. To keep the exposition simple and to conserve project resources, only three other variables—Armed Forces Qualification Test (AFQT) percentile, the civilian/military wage ratio, and the civilian unemployment rate—have been included (in an admittedly sketchy fashion).

[1]Expiration of Term of Service—the time when an individual comes up for reenlistment.

[2]The elasticity of the reenlistment rate with respect to the bonus step is defined as the proportional change in the reenlistment rate, per proportional change in the bonus step. SRB or bonus improvement factors are commonly defined as the proportional change in the reenlistment rate per one step change in the SRB.

The concluding section (Section V) describes how a fully specified model would have to be developed, and what tradeoffs researchers would be faced with. The main contribution of the report is thus not the empirical results which, in view of the sketchiness of the empirical specification, have to be interpreted with caution, but the realization that superior methodologies to the standard logit and probit models exist, and that they can indeed be implemented.

ESTIMATING BONUS IMPROVEMENT FACTORS

The effect of SRBs on retention is a well-researched field. Chow and Polich [1980] present comprehensive overviews of the different approaches and models used. Only those that are directly relevant to this research effort are cited here.

It is customary to model the stay/leave decision in a logit or probit framework. Some, e.g., Hosek and Peterson [1985] and Lakhani and Gilroy [1984], take three options into account: stay, leave, or extend; most confine the analysis to two options (stay or leave). The relevant population is taken to be the individuals who reach the reenlistment point in their career; possible lead and lag effects of bonus are rarely treated in great detail.

It is probable, though, that the expectation of a bonus has a lead effect. Individuals expecting a bonus are more likely to reach the reenlistment point than those who do not expect a bonus. Similarly, one would expect a lag effect: Individuals who were induced by a bonus to remain in the service at the first reenlistment point are probably more likely to leave at the second reenlistment point than are those who would have chosen a military career even without a bonus. This effect has been observed by Warner and Simon [1979] and Rodney et al. [1980].

In order to identify and estimate a bonus improvement factor, it is important that the bonus variable vary over the sample. But individuals reaching the reenlistment point at the same time within a specialty are offered the same bonus step. It is therefore not possible to estimate from historical data bonus improvement factors for a cohort within a specialty. Bonus improvement factors can only be identified by comparing different cohorts, if they were offered different bonus steps, or by comparing different specialties that received different bonuses. The first method is usually called the time-series approach, whereas the second is called the cross-sectional approach. Both methods have their respective drawbacks.

Most studies of bonus effects are based on cross-sectional data. The bonus improvement factors estimated by Nelson [1970], Kleinman and Shugart [1974], Enns [1975], Warner and Goldberg [1984], among others, depend largely on the variation of SRB steps among specialties for econometric identification. The danger in this approach is a potential simultaneity bias. Not only are reenlistment rates influenced by bonus, but bonus steps are also influenced by reenlistment rates: Bonus managers will tend to allocate bonuses to those specialties where reenlistments are insufficient.

One way of reducing simultaneity biases resulting from the way in which bonuses are determined is to use pooled cross-section time-series data and to allow for specialty-specific reenlistment rates. Warner and Simon [1979] and Hosek and Peterson [1985] have used this approach. It can be implemented by either subtracting out the average reenlistment rate for each specialty (e.g., by including a dummy variable for each specialty), or by differencing the observations (regressing changes in reenlistment rates on changes in bonus steps). Although these procedures correct for differences in basic reenlistment rates among specialties, they still assume that the *changes in reenlistment rates* in response to changes in the bonus step are the same across specialties.

Enns [1975] found evidence that this may not necessarily be true. More recently, Rodney et al. [1980] and Lakhani and Gilroy [1984] have estimated bonus improvement factors or elasticities for groups of skills. Rodney et al. use a clustering algorithm to place Navy ratings into three groups, characterized by high, medium, or low responsiveness. They find that "administrative personnel have a higher than average response to bonus awards." Lakhani and Gilroy, grouping Army occupations according to career management fields, find that "occupations that are risky, technical and/or in high civilian demand tend to have low elasticities." Beyond such general observations, however, differences in bonus improvement factors among skills remain largely unexplained.[3]

Also unexplained are the groupings on which the estimates are based. Groups such as Department of Defense occupation codes (DoD-OCC) or career management fields (CMF) often group occupations that have little in common. More importantly, such an approach does not resolve the basic problem of simultaneity biases. But to go one step further and analyze responsiveness to SRBs by individual skill is quite difficult, and requires use of the time-series approach.

[3]It seems that the explanations offered are more apt to explain differences in basic (average) retention rates among skills, rather than differences in the marginal responsiveness to changes in SRB steps.

The time-series approach is based on comparing reenlistment rates for different cohorts within the same skill. It is feasible for those specialties that have experienced some changes in SRB steps. Its main drawback is that it requires controlling for the effects of a number of variables that also vary over time. Specifically, one has to keep in mind that changes in the civilian unemployment rate, the ratio of military to civilian pay, and similar variables will influence the opportunity costs an individual faces when deciding to leave the service or to stay. In addition, it may be that the composition of cohorts changes over time, or the characteristics of the job change. In addition, the services' personnel policies change, especially with respect to qualification requirements and promotion opportunities.[4]

If all these variables are controlled for, it may be difficult to identify bonus effects. SRB steps for individual specialties do not vary a great deal over time. Hosek and Peterson [1985] have estimated the correlation of SRB steps in adjoining periods to be approximately 0.8 for those specialties that receive a bonus at all. In other words, for most specialties that receive a bonus in period t, there is a very good chance that they will receive the same bonus in period $t + 1$. If the few changes that do take place over time are furthermore associated with other changes in personnel policies (qualification requirements, promotions), it may be impossible to estimate bonus effects from time-series data.

Nevertheless, wherever possible, time-series estimates appear to be preferrable to cross-section estimates. It is possible to quantify most of the variables that are required to control for outside effects (unemployment, pay), and even the composition of the cohorts can be controlled for. Changes in the attractiveness of a particular military occupation over time are more difficult to quantify; however, it is unlikely that such changes are as dramatic as the differences in attractiveness across specialties. Differences in bonus improvement factors across specialties probably depend on some combination of variables that make up the quality of military life. Attempts have been made, particularly in the Navy, to approximate this through measurable variables such as sea/shore rotation (e.g., Nakada [1984], Cowin and O'Conner [1980]). In general, however, it is difficult to find variables that might describe those characteristics of military jobs that lead to differences in bonus response.

Skill-specific bonus improvement factors would obviate, to a large extent, the need for quantifying these characteristics. They would also meet the needs of manpower planners more directly. Bonus improve-

[4]Some of these variables should be controlled for in a cross-sectional analysis as well.

ment factors are always used to forecast changes in reenlistment rates for individual specialties, and estimates based on differences in reenlistment rates among specialties may not be appropriate, especially if bonus improvement factors should vary dramatically from one skill to another.

ORGANIZATION OF THE REPORT

This report presents a methodology for estimating specialty-specific bonus improvement factors, based on survivor functions. Survivor function models have recently become popular in military personnel research (see, for example, Nakada [1984]). However, most applications use survivor models to track the survival of a specific cohort over time which makes them ill-suited for estimating bonus effects. The model described here combines different cohorts, and then tracks individuals over their time in the service. In this manner, it is possible to observe individuals coming to their reenlistment point at the same time,[5] but because they are from different cohorts, they face different bonus steps. In addition, the model extends the proportional hazards framework and allows for nonproportional effects. It is thus possible to identify separate lead and lag effects for each half-year period before and after the reenlistment point. The model is described in detail in Section II.

Section III presents the empirical estimates obtained by applying the survivor function model to 15 specialties/ratings from all four services. The results not only show that it is possible to estimate specialty-specific bonus improvement factors for at least some specialties, but they also reveal that there are large differences in the way in which servicemen and -women in different skills react to the bonus incentives offered. This casts serious doubts on estimates of bonus improvement factors that do not allow for skill-specific effects.

The bonus improvement factors implied by the estimates of Section III are presented in Section IV. In accordance with the model, there are two kinds of bonus improvement factors that have to be considered. It is possible to estimate a separate bonus improvement factor for each period. For example, it is possible to find that a one-step increase in the bonus from the sample mean will increase retention in the ETS period by 10 percent, but reduces it in period 8 (four years after the ETS period) by 6 percent. It is also possible to calculate an overall measure of the bonus' effectiveness by combining the period-specific

[5]Here "time" is measured by time from the ETS point.

bonus improvement factors into an overall measure reflecting the additional man-years of service generated by a one-step change in the SRB. Theoretically, this man-year measure should extend over the entire career profile of a serviceman or -woman; in practice, however, we can only estimate the additional man-years created in the period from one to one-and-one-half years prior to the first ETS until four-and-one-half to five years after the first ETS.

The conclusions are discussed in Section V. It seems that the bonus improvement factors estimated by the survivor function approach are not only feasible, but offer some distinct advantages over alternative estimates. Their drawback is that at present there are only a limited number of skills for which specific bonus improvement factors can be estimated. It may be possible to enhance the usefulness of the available estimates by using them as proxies for related or similar skills.

To obtain more reliable estimates for a larger number of specialties, a bonus experiment ought to be considered. In an experimental setting it is possible to control for some environmental variables, such as GNP and civilian unemployment rates, through the design of the experiment. This frees up degrees of freedom for the analysis. It is also possible to randomize the experimental treatment to assure that the effects of particular interest, i.e., the bonus effects, are properly identified. Because the current research raises serious questions about the appropriateness of the commonly used parameter estimates obtained from cross-sectional or pooled analyses, such an experiment warrants further consideration.

II. A SURVIVOR FUNCTION FRAMEWORK TO ESTIMATE BONUS EFFECTS

The model discussed in this section is based on a survivor function which traces the survival of individuals in their military careers. "Time" thus always refers to time in the military, and not to calendar time, unless otherwise noted. For a thorough treatment of survivor function models, see Kalbfleisch and Prentice [1980].

THE MODEL

Let $f(t_j)$ be the unconditional probability that an individual will leave his specialty during time period t_j. The probability that he will leave during or before time t is thus

$$F(t) = \sum_{t_j < t} f(t_j) \tag{1}$$

The probability that he will stay past t (the survivor function) is given by $S(t) = 1 - F(t)$ and the probability that he will leave during the interval t_j, given that he has "survived" to the beginning of t_j (the hazard function), is

$$\begin{aligned} \lambda_j &= P(T = t_j \mid T \geq t_j) \\ &= \frac{f(t_j)}{S(t_j)} \end{aligned} \tag{2}$$

The conditional probability that an individual does not leave during period t_j, given that he has not left prior to reaching t_j, is equal to $1 - \lambda_j$. The survivor function can therefore also be expressed as

$$S(t_j) = \prod_{i<j} [1 - \lambda_i]$$

= Probability that individual does not leave prior to the beginning of t_j.

Accordingly, the unconditional probability that an individual will leave during period t_j is given by

$$f(t_j) = \lambda_j \prod_{i<j} [1 - \lambda_i] \tag{4}$$

The probability that an individual stays in the service depends on a set of explanatory variables X_t. Analogous to the proportional hazards model for continuous time survivor functions, a discreet equivalent can be specified:

$$S(t, X_t) = S_0(t)^{\exp(X_t\beta)} \tag{5}$$

where $S_0(t)$ is the "baseline" survivor function (for $X_t = 0$).[1] If the hazard function corresponding to S_0 has contribution λ_i at t_i, then

$$S_0(t_j) = \prod_{i<j} (1 - \lambda_i) \tag{6}$$

and

$$S(t_j, X_t) = \prod_{i<j} (1 - \lambda_i)^{\exp(X_t\beta)} \tag{7}$$

= Probability of staying in the service past the beginning of t_j.

The probability that an individual with characteristic X_t will leave during period t_j, conditional on his having stayed until the beginning of t_j (i.e., the hazard at t_j), is then given by

$$\lambda(t_j, X_t) = 1 - (1 - \lambda_j)^{\exp(X_t\beta)} \tag{8}$$

Experience has shown that convergence of the nonlinear estimation algorithm is improved if the transformation $\gamma_j = \log[-\log(1 - \lambda_j)]$ is used (Kalbfleisch and Prentice [1980]). The discrete hazard function can then be written as

$$\lambda(t_j, X_t) = 1 - \exp[-\exp(\gamma_j + X_t\beta)] \tag{9}$$

---

[1]Note that the covariates X_t may be constant over time (e.g., sex, race), or may be time dependent (e.g., age, number of dependents). In addition, they may vary by cohort and time (e.g., unemployment rate, pay).

This transformation[2] also removes any range constraints from the estimated parameters. For γ_j minus infinity, the hazard is zero, and for γ_j plus infinity, the hazard is one.

A censored observation arises when no further information about an individual after a certain point in time is available. This may be due to missing data, or simply because our observations end. For example, the latest data used in this study are from the second half of FY 1983, and no further information is available on the individuals still in the service. All that is known is that they stayed at least until this point. The probability of an individual with characteristics X_t surviving to at least t_j is given by the survivor function (7) above. Using the new notation, (7) can be rewritten as

$$S(t_j, X_t) = \prod_{i<j} \exp[-\exp(\gamma_i + X_t\beta)] \tag{10}$$

The log likelihood of m individuals with characteristics $X_{rt}(r = 1,2,...,m)$ leaving during period t_j, and ℓ individuals with characteristics $X_{rt}(r = m + 1,...,m + \ell)$ being censored during this period, is therefore equal to

$$\log L_j(\gamma_j,\beta) = \sum_{r=1}^{m} \log\{1 - \exp[-\exp(\gamma_j + X_{rt}\beta)]\} \tag{11}$$

$$+ \sum_{r=m+1}^{m+\ell} -\exp(\gamma_j + X_{rt}\beta)$$

Summing over all k periods yields the log likelihood for the entire sample:

$$\log L(\gamma,\beta) = \sum_{j=1}^{k}\left(\sum_{r=1}^{m}\log\left\{1 - \exp\left[-\exp(\gamma_j + X_{rt}\beta)\right]\right\} - \sum_{r=m+1}^{m+\ell}\exp(\gamma_j + X_{rt}\beta)\right) \tag{12}$$

---

[2] The equivalence of Eqs. (8) and (9) can be seen as follows:

$$\begin{aligned}(1 - \lambda_j)^{\exp(X_t\beta)} &= \exp\{[\log(1 - \lambda_j)] \cdot [\exp(X_t\beta)]\}\\ &= \exp\{-[-\log(1 - \lambda_j)] \cdot [\exp(X_t\beta)]\}\\ &= \exp\{-[\exp(\log(-\log(1 - \lambda_j)))] \cdot [\exp(X_t\beta)]\}\\ &= \exp\{-[\exp(\gamma_j)] \cdot [\exp(X_t\beta)]\}\\ &= \exp\{-\exp[\gamma_j + X_t\beta]\}\end{aligned}$$

Nonlinear techniques have to be used to maximize (12). But once the parameter estimates that maximize this likelihood function are found, the hazard for each period j can be calculated from Eq. (9), and the survivor function from (10). Recall that the time index "j" refers to time relative to an individual's ETS. The period into which an individual's ETS falls is indexed by $j = 0$. Since all service personnel are inherently more likely to leave around their ETS, γ_0 will be larger than the estimate of γ for the other periods.

Up to this point, all the covariates X are assumed to have the same effect on the hazards in the different time periods. The only term that was allowed to vary from one period to the next was the intercept γ_j. This is not a realistic assumption, and the proportional hazard model has to be expanded to allow for period-specific effects of some covariates.

One of the covariates which determines whether an individual is likely to leave or remain in the service is the selective reenlistment bonus (SRB). Before the first reenlistment point (ETS), a servicemember might be induced to stay on by the prospect of being offered a bonus. At the ETS point itself, an SRB is expected to increase the probability that a servicemember decides to stay in the service, and during the period after this ETS, i.e., the second term, servicemembers who received a bonus are more likely to stay at least three more years.[3] Still later, after completing their second term, those who received a bonus might be more likely to leave, since a bonus might attract individuals less committed to military service than those who reenlist even without a bonus.

The effect of the SRB is thus expected to be period-specific. The coefficient of the SRB variable has to be treated in a manner analogous to the treatment of the intercept term γ_j. The notation can be condensed somewhat and (12) can be rewritten as

$$\log L(\gamma,\beta) = \sum_{j=1}^{k} \left(\sum_{r=1}^{m} \log[1 - \exp[-\exp(MU'_{jr})]] - \sum_{r=m+1}^{m+t} \exp(MU'_{jrt}) \right)$$

[3]Bonuses are paid to servicemembers in eligible specialties who recommit for at least three more years. An individual who extends his term of service for a shorter period of time would not be eligible for a bonus. Thus, if an individual who was eligible for a bonus is still in the service after the ETS point he is more likely to have reenlisted rather than extended, and therefore more likely to stay at least three more years.

where MU_{jrt} is given by

$$MU_{jrt} = \gamma_j + \delta_j SRB_t + X_{rt}\beta \tag{14}$$

In an analogous manner, period-specific effects of other explanatory variables can be accounted for, as reflected in other components of the β vector becoming period dependent and acquiring a subscript j. For example, the unemployment rate in the private sector might have different influences on an individual's stay-leave decision at different points in the military career. MU_{jrt} could then contain a term like $\beta_{uj}U$, where U is the unemployment rate and β_{uj} is the coefficient measuring the effect of the unemployment on the hazard of leaving in period j.

DERIVING BONUS IMPROVEMENT FACTORS

Period-Specific Bonus Improvement Factors

Calculation of bonus improvement factors is somewhat simplified if all explanatory variables, except the SRB step, are standardized on a mean of zero. To calculate the hazard of leaving during period j for an individual with average characteristics, one need then only consider the parameters γ_j and δ_j, because the average value for the other explanatory variables is zero. The estimate of β remains unaffected by this transformation.

By definition, the conditional continuation rate in period j, i.e., the probability that an individual with average characteristics who is in the service at the beginning of period j is still in the service at the end of period j, is given by

$$C_j = 1 - \lambda(t_j) \tag{15}$$

At the sample mean ($X_{rt} = 0$), this is equal to

$$C_j = \exp[-\exp(\gamma_j + \delta_j \cdot SRB)] \tag{16}$$

With estimates for the parameters γ_j and δ_j, this expression gives the average continuation rates for each period j as a function of the bonus paid in the ETS period.

The elasticity of C_j with respect to the SRB step is given by

$$\eta \equiv \partial \log(C_j)/\partial \log(SRB) \tag{17}$$

Multiplying η by the proportional change in the SRB step will give the proportional change in C_j. The bonus improvement factor for C_j, defined as the proportional change in C_j in response to a one-step increase, is thus given by

$$b_j = \eta / SRB \tag{18}$$

Most researchers estimate constant elasticities. As can be seen from Eq. (18), the bonus improvement factors decline as the SRB step increases. This result corresponds to observed behavior and is intuitively appealing, for it implies diminishing marginal utility of bonus income to servicemen and -women. However, Eq. (18) by itself does not require that the new continuation rate predicted for a new bonus step fall within the permissible range from zero to one. In addition to declining with increasing SRB steps, the bonus improvement factor b_j should also asymptotically approach zero, as C_j approaches one.

In the survivor function framework presented here this is the case. Applying Eq. (17) to Eq. (16), we obtain:

$$\partial \log(C_j)/\partial \log(SRB) = [\partial \log(C_j)/\partial SRB] \cdot [\partial SRB/\partial \log(SRB)] \tag{19}$$

$$= \log(C_j) \cdot \delta_j \cdot SRB$$

Dividing by SRB to find the bonus improvement factor for a one-step increase in the SRB results in

$$b_j = \log(C_j) \cdot \delta_j \tag{20}$$

As C_j approaches one, log C_j approaches zero, as does the bonus improvement factor b_j.[4]

Man-Year Effects

The period-specific bonus improvement factors derived above provide only a partial answer. The question that one ultimately has to address is: How many more man-years does a one-step increase in the bonus buy? In graphical terms, the man-years served are the integral under the survivor function. The effect of a one-step increase in the SRB on the man-years served is given by the integral of the area

[4]This formula for the bonus improvement factor is based on the point elasticity, and is thus valid for small changes in the bonus step only. In practice, even a one-step change in the bonus is nonmarginal, and one should use a bonus improvement factor based on the arc elasticity, say b_j^* instead of b_j. This measure is then defined as $b_j^* = (C_j^1 - C_j^0)/C_j^0$, where C_j^1 and C_j^0 are continuation rates evaluated at the new and old bonus steps, respectively.

between two survivor functions that are constructed for bonuses one step apart.

If the bonus had an effect only in the first period, the answer to this question would be straightforward. The two survivor functions would then be proportionally parallel and the proportional increase in man-years served by individuals who receive the bonus would be the same as the proportional increase in first period retention. However, the bonus step change usually affects retention in subsequent periods as well. As outlined in the introduction and in the subsection above, bonuses paid at the first ETS are likely to produce different effects on retention in different periods. This has to be taken into account.

Theoretically, the expected man-years M would have to be calculated by integrating under the entire survivor function from period zero until the maximum retirement age. In practice, however, it is doubtful whether a bonus that will be paid if the individual reenlists at his or her first reenlistment point influences retention in a period far from the first ETS. The real interval that needs to be considered is considerably smaller, say from $j = -2$ to $j = 9$.[5]

Figure 1 gives a hypothetical example of how to calculate man-year effects. The lower survivor function is plotted at the initial bonus step B_0, whereas the upper figure is plotted at the bonus one step higher. In the early periods, at and around the ETS period, the bonus tends to reduce the hazard of leaving, which is shown by a reduction in the slope of the survivor function in absolute terms (the survivor function is flatter). Toward the end of the second term, the hazard of leaving for people who received a higher bonus increases, because individuals who were induced by a bonus to stay on come to the end of their term and leave. The survivor function at the higher bonus step again approaches the old survivor function. This example has been constructed so that after period 9 the two survivor functions are again the same.

Given this survivor function model, the man-years of service expected from individuals over the six-year interval ranging from period −2 to period 9, conditional on the individual having reached the beginning of period −2, is given by

[5]The unit of time used in this study is fiscal half years ("semesters"). The index $j = -2$ therefore refers to the six-month period one year prior to the semester in which the ETS falls. Accordingly, $j = 9$ refers to a half-year period 4.5 to 5 years after the ETS.

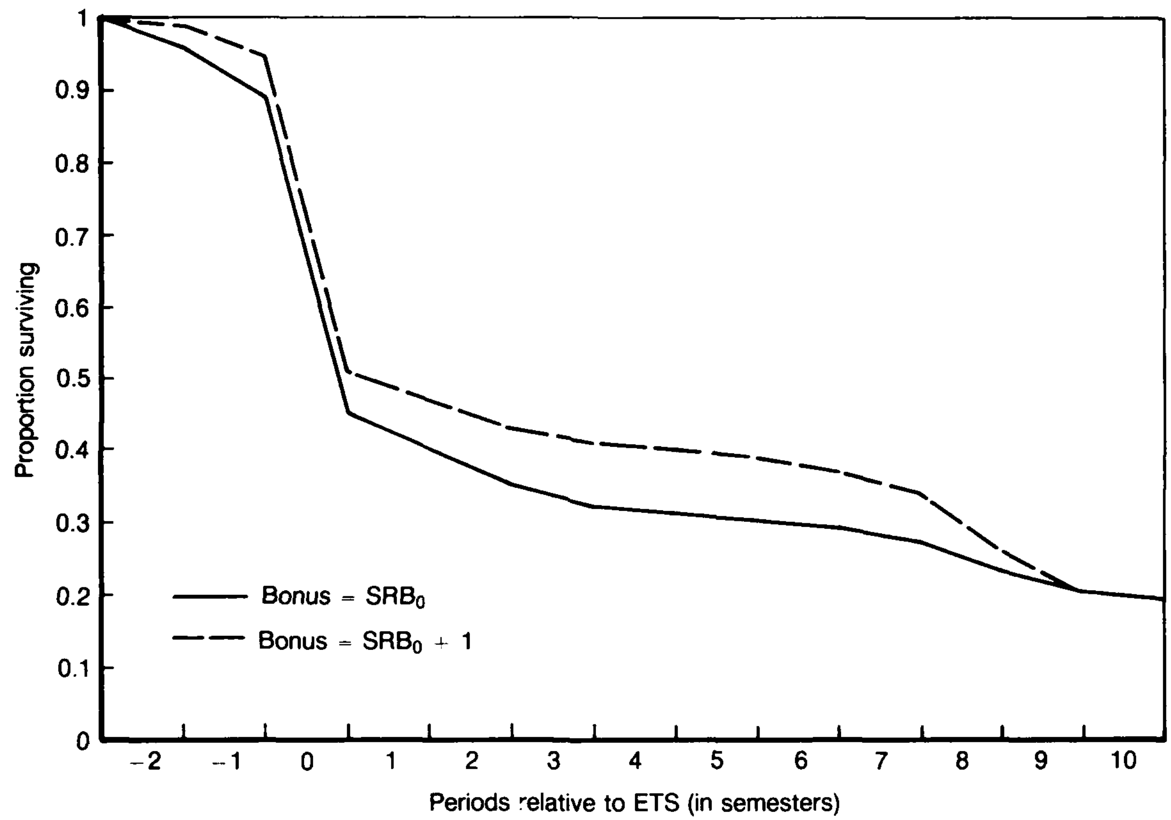

Fig. 1—Hypothetical survivor functions

$$M(SRB) = \left[\sum_{j=-2}^{9} \prod_{i=-2}^{j} C_i \right] \cdot \frac{1}{2} \tag{21}$$

$$= \left[\sum_{j=-2}^{9} \prod_{i=-2}^{j} \exp[-\exp(\gamma_i + \delta_i \cdot SRB)] \right] \cdot \frac{1}{2}$$

The expected man-years M are a function of the SRB, because the survivor function is a function of the SRB. The adjustment factor—dividing by two—is necessary because in this particular case time is measured in half-year units.

Analogous to the single-period case considered above (see Eqs. (17) and (18)), an elasticity of M with respect to the SRB step can be defined. However, the algebra is somewhat simpler if the alternative definition of the elasticity of the expected man-years with respect to the SRB (η_M) is used:

$$\eta_M \equiv \frac{\partial M}{\partial SRB} \frac{SRB}{M} \tag{22}$$

Dividing this elasticity by the initial bonus step (SRB) results in the bonus improvement factor:

$$B = [\partial M / \partial SRB] \cdot [1/M] \tag{23}$$

Applying Eq. (23) to the expression for M (Eq. (21)) is straightforward but exceedingly tedious. After some simplification, we obtain:

$$B = \left[\sum_{j=-2}^{9} \frac{\partial C_j}{\partial SRB} \cdot \frac{1}{C_j} \left[\sum_{h=j}^{9} \prod_{k=-2}^{h} C_k \right] \right] \cdot (2M)^{-1}$$

which is equivalent to

$$= \left[\sum_{j=-2}^{9} b_j \left[\sum_{h=j}^{9} \prod_{k=-2}^{h} C_k \right] \right] \cdot (2M)^{-1} \tag{24}$$

The additional man-years M^+ that a one-step increase in the SRB "buys" over the interval from period −2 to period 9 is simply B multiplied by M, i.e.,

$$M^+ = (1/2) \left[\sum_{j=-2}^{9} b_j \left[\sum_{h=j}^{9} \prod_{k=-2}^{h} C_k \right] \right] \tag{25}$$

Equations (24) and (25) can be interpreted as weighted sums of the individual period bonus improvement factors. Each period's bonus improvement factor is weighted by that portion of the survivor function on which it has an influence, i.e., the period j bonus improvement factor is weighted by the area under the survivor function from period j onward. This area, given by the term in the innermost brackets in Eqs. (24) and (25), may change in response to changes in earlier continuation rates; however, for small changes in bonus steps around the point at which the continuation rates are evaluated, the formulas, based on the marginal effects, are accurate.

SRB changes, on the other hand, are usually undertaken in full step increments, which amount to substantial changes, relative to the average bonus step. In this case, two corrections are in order: first, we have to use the arc-based bonus improvement factor b_j^* (see footnote p. 13), and second we have to take into account the effect that changes in earlier continuation rates have on the remainder of the survivor function.

Consider the effect of a bonus change on expected man-years in sequence. Assume that an increase in the bonus step increases the continuation rate in the first period, and thus shifts up the entire survivor function proportionately. A proportional change in the continuation rate in the second period has now a larger influence on the expected man-years. In fact, the expected man-years from the second period on are now $1 + b_1$ times what they were before the change in the first period's continuation rate.

In practical terms, this adjustment simply means that the value for man-years remaining from period j onward has to take into account the changes brought about by changes in earlier continuation rates. In Eqs. (24) and (25), this correction is achieved by multiplying the term in the innermost brackets by a factor reflecting the compounded effects of changes in earlier continuation rates, i.e., the corrected formulas[6] become

$$B = \left[\sum_{j=-2}^{9} b_j^* \left[\sum_{h=j}^{9} \prod_{k=-2}^{h} C_k \right] \cdot \prod_{n=-2}^{j-1} (1 + b_n^*) \right] \cdot (2M)^{-1} \tag{26}$$

and

[6]For an alternative derivation of these formulas, see Appendix D.

$$M^{+} = (½)\left[\sum_{j=-2}^{9} b_j^{*}\left[\sum_{h=j}^{9}\prod_{k=-2}^{h} C_k\right]\cdot\prod_{n=-2}^{j-1}(1 + b_n^{*})\right] \tag{27}$$

This is the incremental man-years measure against which the costs of the bonus must be compared. It is defined on a "per individual" basis. The expected man-years served by each individual over the time interval from period −2 to period 9 can be increased by an amount given by Eq. (25) for a one-step increase in the SRB.

Note that M^{+} is in time units (years of service), whereas B is a pure number (proportion). This distinction is important because of the truncation of the observation interval. If the SRB indeed has no influence on continuation rates outside of the observation interval, and at the end of period 9 the two survivor functions again coincide (the case depicted in Fig. 1), then M^{+} is a correct measure of the total additional man-years resulting from the bonus step increase. As a proportion of total man-years served over a servicemember's entire career, from period −2 on, this number is smaller than B. It would be incorrect to apply the bonus improvement factor B to the total man-years served from period −2 until retirement; as a measure of the bonus effect over the entire career profile, B is an overestimate.

If after period 9 the survivor function at the higher bonus is still above the survivor function at the initial SRB, then M^{+} fails to capture the entire increase in man-years occasioned by the bonus. It does not take into account that more people will reach the beginning of period 10 and therefore a higher number will probably reach the beginning of period 11, and so forth. M^{+} is thus a lower bound for the total increase in man-years due to the SRB increase. B applied to the total expected man-years from period −2 until retirement would be an extreme upper bound.[7]

This upper bound estimate can be improved upon. Let M_9 denote the man-years expected from period −2 until period 9 at the initial bonus step. From Eqs. (24) and (25) follows the simple equivalence $B = M^{+}/M_9$. Let M_R denote the man-years expected from an individual with average characteristics from period −2 until retirement. As noted above, $B \cdot M_R > M^{+}$. Assume that at the end of period 9, the survivor function at the higher bonus step lies above the initial survivor function by a fraction α. If the hazards of leaving in all subsequent periods remain unaffected by the SRB, the survivor functions will be proportional to each other from period 9 on. The total

[7]This assumes that the SRB would not reduce the hazard of leaving in periods >9.

additional man-years bought with the bonus step increase are therefore given by $M^+ + \alpha(M_R - M_9)$, which is greater than M^+ and probably less than or equal to $B \cdot M_R$.[8]

Consider a simplified numerical example. Table 1 lists assumed conditional continuation probabilities (C_j) and assumed bonus improvement factors (b_j^*). The assumptions underlying Table 1 imply an increase in the reenlistment rate of approximately 15 percent, two-thirds of which coming from individuals who otherwise would have left the service (increase in continuation rate in period 0 by 10 percent), and one-third from individuals who would have first extended and then left the service (increase in continuation rate in period 1 of 5 percent). A methodology that only considers what happens at the reenlistment point would thus result in an estimated bonus improvement factor of around 15 percent.

But since some of the individuals who reenlisted would have extended and thus served at least some time even in the absence of the bonus increase, the proportional net addition to man-years served is less than the proportional increase in reenlistments would lead us to believe. In this example, the net increase in man-years, as evaluated by Eq. (24) over the first four years (periods 0 through 3), is only about 12 percent.

For this example, we have not assumed that the individuals who by means of a bonus were induced to reenlist at the first reenlistment point are more likely to attrit during the second term. However, we have assumed that they are less likely to reenlist after the second term, an assumption reflected in the negative bonus "improvement" factor

Table 1

HYPOTHETICAL NUMERICAL EXAMPLE

	Time from ETS (years)					
	0	1	2	3	4	5+
Conditional continuation probability, C_j	.5	.8	.95	.95	.75	.98
Bonus improvement factor, b_j^*	.1	.05	0	0	-.1	0

[8]This assumes that α is less than or equal to B, which is the case if the SRB increases the hazard of leaving toward the end of the second term. It is conceivable, although unlikely, that $\alpha > B$, in which case the true increase in man-years, assuming no negative influence of the SRB on hazards of leaving in periods later than 9, would exceed $B \cdot M_R$.

for year 4. This tends to further reduce the net proportional increase in man-years "purchased" by a bonus increase. Equation (24) applied to the first five years gives a man-year bonus improvement factor of only about 12 percent. If we extend the time horizon of the analysis to 10 years after the first ETS, a .suming that the bonus effects after year 5 are all zero, the proportional increase in man-years generated by the bonus increase drops to less than 10 percent. However, the actual number of additional man-years generated (M^+) continues to increase, as the drop in the continuation rate in year 4 does not quite offset the increases in years 0 and 1.

III. EMPIRICAL RESULTS

HYPOTHESES

This study concentrates on the effects of bonuses paid at the first reenlistment point (first ETS) only. There are a number of studies that have analyzed first-term reenlistment, or have reviewed the substantial literature on this topic (Enns [1975], Chow and Polich [1980], Goldberg and Warner [1982], and Rodney et al. [1980], among others). Most of the hypotheses that our model is designed to investigate have appeared in the literature and have been tested to varying degrees. The novel feature of our approach is that it makes it possible to test the hypotheses for individual specialties. If the responsiveness to bonuses varies across specialties (and this study will document large such variations), it is important that bonus program managers be aware of the variations, so that they can allocate the bonus budget in the most effective manner.

There is no "correct" model for estimating bonus effects. Depending on the particular hypothesis of interest, one type of model may be more suitable than another. The main advantage of the survivor function approach is that it allows identification and estimation of differential effects that a bonus might have on continuation probabilities at different points in a servicemember's career. For example, it is possible to determine whether individuals who were offered a bonus at their first reenlistment point have a higher or lower probability of continuing past the second reenlistment point than are individuals who were not offered a bonus. Economic theory suggests a number of hypotheses in this context:

- Servicemembers are usually well aware of the bonus they can expect if they reenlist for a second term. Therefore, a bonus paid at the first ETS should lead to reduced attrition during the later years of the first term.[1] This effect may be confounded, however, by changes in service policies regarding early release of servicemembers. It is likely that in a shortage specialty, an

[1]Servicemembers who have decided not to reenlist do not necessarily have to wait until the end of their first term before being released from service. Even though the particular policies vary across services and over time, services' directives provide for early exit at the member's request or for other reasons deemed to be in the service's interest. Early separation for hardship or to enable the servicemember to attend school are common examples. These "early out" options were particularly widespread in the early and mid seventies, years from which a substantial portion of our data derive.

increase in the SRB step will be accompanied by a tightening of conditions for early release. It is also probable that these conditions are varied to facilitate meeting end-strength constraints. It is almost impossible to identify these effects separately from the bonus effect with non-experimental data.

- At the first ETS, a higher SRB should improve retention by inducing more individuals to reenlist.
- For the period immediately after the first ETS, higher bonuses should be associated with higher continuation rates, as more servicemembers choose to reenlist rather than extend. If most extenders, however, reenlist later anyway, this effect could be small.
- In years 2 and 3 after the first ETS, one would expect little effect of bonuses on attrition. It is possible that servicemembers who received bonuses and who have a lower taste for the military might be slightly more likely to attrit before the completion of the second term.[2] However, this effect is probably not very large.
- Four years after the first ETS, at the second reenlistment point (periods 8 and 9), one would expect higher first-term bonuses to be associated with lower retention. Bonuses are likely to have induced individuals with lower tastes for the military to remain in the service. These individuals are less likely to reenlist at the second reenlistment point, other things being equal.

This last hypothesis would have to be modified for specialties where three-year reenlistments predominate. In this case, the expected effect of the first-term reenlistment bonus in reducing retention would become operative before period 8. Also note that by the same argument as for attrition before the first ETS, there is the possibility that individuals opt for an "early out" before the end of the second term if they have decided not to reenlist again. The model presented here allows for all these effects, through the estimation of period-specific bonus effects, although no unambiguous testable hypotheses can be specified. (A Bayesian would describe this as a "diffuse prior.")

Hypotheses for the other explanatory variables in this analysis—unemployment, the military/civilian wage ratio, and the AFQT score (percentile)—are not developed here. In the current specification, these variables serve as control variables, and may be correlated with a

[2]Note that the inherent unattractiveness of specialties receiving bonuses does not enter into consideration here, because the analysis is specialty specific. People receiving bonuses are compared with people not receiving bonuses *in the same specialties*, and thus exposed to the same conditions with respect to their military job.

number of other excluded variables. It is, for example, not clear whether higher unemployment rates should increase attrition during the first term or not. Higher unemployment also leads to higher enlistments, and the services might thus be more willing to let servicemembers go before completing their first term.

Nevertheless, the direction of the effect of the economic variables (unemployment and pay ratio) on reenlistment and retention in the different periods can be specified. In general, one would expect higher unemployment, as well as higher military to civilian pay ratios, to be associated with higher retention throughout. Because it was not possible, under the current project, to conduct additional analyses and to control for other individual specific variables, such as race and sex, it is doubtful that the estimated effects for the AFQT variable can be correctly interpreted. It would be questionable to propose specific hypotheses regarding the coefficients estimated for a variable that so clearly captures all sorts of contradictory effects in this model.

DATA AND VARIABLES

The data consist of semi-annual observations on individuals drawn from the Defense Manpower Data Center (DMDC) personnel files. The period of observation ranges from FY1974 through FY1983. Fifteen primary occupation specialties (PMOS in the Army and Marine Corps, AFSCs in the Air Force, and ratings in the Navy) were included in the analysis.[3] The choice of occupation specialties was dictated primarily by the need to have sufficient variation in the bonus variable and an adequately large number of individuals within the specialty to carry out the estimation.[4] In addition, an effort was made to select occupations out of the same DoD occupation codes to allow for comparisons across services. Overall, five different DoD occupation codes are represented.

A servicemember's career was divided into half-year periods. The periods were numbered starting with zero for the fiscal half year into which a servicemember's first ETS falls,[5] thus avoiding any problems

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[3]For simplicity we will refer to all of them as occupation specialties or PMOS.

[4]The Air Force AFSC 304x1, 328x1, 328x3, and 328x4 are all part of the same DoD occupation code (102: Navigation, Communication and Countermeasure, n.e.c.). Individually, they were too small or had insufficient variation in SRB steps to make estimation of bonus effects possible. For this analysis, they were combined into one aggregate specialty labeled "Air Force Combined" (AF-COMB).

[5]The ETS used in this study is the "hard" ETS, i.e., the end of the contractually obligated term of service. Some records, especially for Air Force and Navy personnel, also contain a "soft" ETS, which indicates an individual's professed intentions, without contractually obligating him to stay until that time.

that might arise from a mixture of three- and four-year first-term enlistments. By this counting, periods before the first reenlistment point have a negative index, whereas those after the first reenlistment point have a positive one.

This assumes that individuals with initial commitments of different lengths have similar responses to SRBs. In view of the fact that the actual bonus paid depends on an individual's basic pay, and thus on his years of service, this is not a very realistic assumption. One way to resolve this problem in later versions of the model is to include years-of-service and base-pay variables.

It would be unreasonable to expect the expectation of a bonus to have an influence on an individual very early in his or her career. Any lead effects of bonuses are probably confined to one to two years before ETS. For this reason, attrition during the early part of the first term was disregarded. The relevant population are thus all servicemembers in each of the 15 specialties that have one to one-and-a-half years to go until their first ETS.

Similarly, it is doubtful that the lag effects of a bonus extend past the second reelistment point. Any observed effect of a bonus paid at the first reenlistment point on the hazard of leaving more than 4.5 years after the first ETS is probably due to some spurious correlation and not the result of optimizing decisions by the enlisted personnel. Furthermore, the number of observations and the variance in the bonus among them drops drastically after about period 8 or 9. For this reason, only the six-year segment of a servicemember's career, starting with period −2 (1 to 1.5 years before ETS) and ending with period 9 (4.5 to 5 years after the ETS period), was analyzed in this study.[6]

Since the primary purpose of this analysis was to identify and estimate the bonus effects, other variables that influence a servicemember's stay/leave decision were treated rather summarily. Only three other variables were included—the ratio of the monthly military base pay to the hourly wage in manufacturing, the overall unemployment rate, and the AFQT score (percentile)—as indicators of individual characteristics. Other variables that have been found to be of influence, such as the form of the bonus payment (Hosek and Peterson [1985]), attitudes (Buddin [1981]), and race (Chow and Polich [1980], Enns [1975], Warner and Simon [1979] among others) are for the time being ignored. Furthermore, to conserve on degrees of freedom, the effect of the included variables on the period-specific continuation

[6]For some specialties, it was possible to estimate up to 16 periods, starting with period −4 and going through period 11. However, few additional insights could be gained from these estimates, and they are not presented here.

rates, unlike bonus effects, were constrained. The unemployment rate, the wage ratio, and the AFQT score were assumed to have the same effect in all periods prior to the first ETS, a possibly different effect during the ETS period, and a third effect on all the periods after the first ETS. This reduces the number of parameters for each included variable to three instead of 12.

It is likely that the exclusion of some explanatory variables, particularly race and sex, affects the calculated bonus improvement factors. However, it was not possible to conduct more extensive analyses and to include more variables in the estimation for this study. The computing costs were already high, and further experimentation with additional model specifications, using larger sets of explanatory variables, would have required more resources than were allocated to this project. To demonstrate the feasibility of the methodology, the current sparse specification is sufficient. However, in future studies of reenlistment using the survivor function model presented here, other explanatory variables will have to be considered.

Unlike the bonus variable, which for every period was defined as the SRB step in effect during the fiscal half-year containing the individual's ETS, the two economic variables—unemployment and wage ratio—were taken contemporaneously. For every period, the value of these variables was the average of all the monthly values during the fiscal half-year corresponding to this period. For example, an individual whose ETS fell into the first half-year of FY1977 had the bonus step in effect at this time as the bonus variable for all his periods. However, the values of the economic variables during the first half of FY1977 determined the corresponding values for his period 0 record only. In his period 1, the values for the unemployment and wage rate variables were given by the average monthly values for these variables during the second half of FY1977, for period 2 the first half of FY1978, and so forth. The value of the fourth explanatory variable, AFQT percentile, is of course constant over time.

ELIGIBILITY

A servicemember's record contains two variables that indicate his or her eligibility for reenlistment. The one most commonly used today is the Reenlistment Eligibility Code (RE-Code). It apparently gives a clear-cut indication of whether an individual would be eligible to reenlist. In practice, however, this code must be interpreted with great caution.

Its most important drawback is that it has historically not been coded in a consistent manner across services, or even within individual services. Individuals who were conditionally eligible to reenlist, or were only eligible to reenlist with a waiver, were sometimes coded as "1" (eligible) and sometimes as "2" (ineligible). Furthermore, the data are simply missing for a great number of people in the mid seventies.

The problems with this variable stem mostly from the use to which it was put. It was used to compute reenlistment rates, which were politically highly sensitive. The officers determining eligibility frequently had some incentives to code individuals who had decided to leave as ineligible for reenlistment, in order to maintain apparently high reenlistment rates for their units. It is not possible to determine what came first—the individual's decision not to seek reenlistment, or his superior's determination that he would have been ineligible anyway.

Many of the problems with the RE-Codes have today been resolved. However, much of our data come from a period for which this variable is highly unreliable. Therefore, on the advice of DMDC, we decided not to condition our estimates on this particular variable.

Another code that contains information on the individuals' reenlistment eligibility is the Interservice Separation Code (ISC). It does to some extent suffer from the same problems as the RE-Code, especially with respect to the incentives faced by the officer making the ISC determination. However, it has been coded more consistently over time and is uniform across the services.

One possible solution to the problem of independent determination of reenlistment eligibility would be a review of each individual's record to determine whether there was independent evidence indicating that he or she would probably not be eligible for reenlistment (e.g., criminal records, failed tests). Such a review was clearly beyond the scope of this project; it was decided instead to test the influence of eligibility, as indicated by the ISC code, by estimating two versions of the model.

One version assumed that anyone who wanted to would be allowed to continue in the service. This assumption is not too unreasonable, since most of the individuals considered in this analysis already have three years of service behind them. If they were unsuited for their military jobs, they probably would have left the service earlier. It is likely that the results of this model will overstate somewhat the effect of bonuses on reenlistments.

The alternative model treated individuals with ISCs larger than one and not between 40 and 49 (entry into officer programs) as censored observations. Since individuals with other ISC codes might also have been eligible for reenlistment (e.g., ISC-03 "to attend school" or ISC-22 "dependency or hardship"), this version of the model will probably understate the bonus effects. As will become apparent in the next subsection, where the coefficient estimates are presented, the effect of treating "ineligibles" as censored observations is essentially confined to the periods prior to the ETS, where it leads to an "improvement" in overall retention and a reduction in bonus improvement factors. Apart from this, the direction, timing, and general magnitude of the bonus effects remain largely unaffected.

COEFFICIENT ESTIMATES

The parameters of the model were estimated by maximizing the log likelihood function (12), using a SAS procedure developed by Rogers and Hanley [1982]. Through interaction with a period-specific dummy variable, as described in Eq. (14), it was possible to estimate the effect of a bonus on the hazard of leaving at different points in a servicemember's career.

To simplify the interpretation of the results somewhat, the three auxiliary explanatory variables—unemployment rate, wage ratio, and AFQT percentile—were standardized by subtracting out the sample means. Therefore, the basic continuation rate in period j of a servicemember's career is given by $\exp[-\exp(\gamma_j + \delta_j SRB)]$, where *SRB* is the bonus step offered at the first reenlistment point. Using this formula, continuation rates for any arbitrary bonus step can be constructed.

For every version of the model, and for each of the 15 specialties, up to 33 parameters had to be estimated. To keep the presentation manageable, the detailed estimates are allocated to Appendix A. In this section, only summary tables and a few illustrative examples are given.

Tables 1a and 1b summarize the results and compare them with the hypotheses outlined above. A + or − indicates a coefficient estimate that is significant at the 0.95 level (absolute t-ratio larger than 1.96). The symbols (+) and (−) indicate coefficient estimates that fall short of the 0.95 level of significance.

One set of results requires some explanation. Occupation code 222 refers to air traffic controllers. This group of occupational specialties seemed particularly attractive for the purposes of this study because it was represented in all four services and comprised a significant number

Table 1a

HYPOTHESES AND ESTIMATED EFFECTS OF BONUS
ON CONTINUATION RATES BY PERIOD
(Unadjusted)

	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
	Hypothesis											
Occupation and Service	+	+	+	+	(+)	?	?	?	?	?	(−)	−
Estimates for DoD-OCC 041: Artillery and Gunnery												
16R (Army)	+	+	+	(+)	(−)	(−)	(−)	(−)	(−)	(+)	(−)	−
GMG (Navy)	+	+	+	+	+	(+)	(−)	(+)	(+)	(−)	(+)	(−)
0811 (Marines)	(−)	+	(+)	(+)	(+)	(+)	(−)	(+)	(+)	(+)	(+)	(−)
Estimates for DoD-OCC 102: Navigation, Communication and Countermeasure												
33S (Army)	−	(−)	+	(+)	+	(+)	(−)	(+)	(−)	(−)	(+)	n.a.
AX (Navy)[a]	(+)	(+)	+	(+)	(+)	+	(+)	(−)	(−)	(−)	(−)	(−)
CTM (Navy)[a]	−	(−)	(+)	(−)	(−)	+	(+)	(−)	−	(−)	(−)	n.a.
AF-COMB[b]	(+)	(+)	(+)	+	+	+	(+)	(−)	−	−	(−)	(−)
Estimates for DoD-OCC 160: Teletype and Cryptographic Equipment, General												
31S (Army)	+	+	+	(+)	(+)	(+)	n.a.	(+)	(−)	(+)	(−)	(−)
Estimates for DoD-OCC 222: Air Traffic Control												
93H (Army)	(−)	(−)	−	(+)	(−)	(+)	(−)	+	(−)	−	−	n.a.
AC (Navy)	−	(+)	+	(−)	(−)	(+)	(+)	+	(+)	+	(−)	n.a.
7322 (Marines)	(+)	(−)	+	(−)	(+)	(+)	(−)	(−)	(+)	n.a.	(−)	n.a.
272×0 (AF)	(+)	−	(+)	(−)	(+)	(−)	(+)	(+)	(+)	(+)	(−)	n.a.
Estimates for DoD-OCC 232: Analysis												
98C (Army)	−	−	+	+	+	(+)	(+)	+	+	(+)	n.a.	n.a.
CTI (Navy)	−	(+)	(−)	(+)	(+)	n.a.	(+)	(−)	(+)	(+)	(−)	(−)
202×0 (AF)	(+)	(+)	(+)	−	(+)	(−)	(−)	n.a.	n.a.	n.a.	n.a.	n.a.

[a]These Navy ratings contain some six-year obligors.
[b]"Air Force Combined," 304×1, 328×1, 328×3, and 328×4.

of people. In addition, the bonus managers have traditionally allocated SRBs to these specialties, and the bonus steps have varied more than most.[7]

Unfortunately, air traffic controllers were also affected by an exogenous shock during the observation period. On August 3rd, 1981, the civilian air traffic controllers went on strike, and on August 5th of the

[7]The bonus steps in effect during the observation period for the 15 specialties considered here are listed in Appendix C.

Table 1b

HYPOTHESES AND ESTIMATED EFFECTS OF BONUS
ON CONTINUATION RATES BY PERIOD
(Adjusted for eligibility)

	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
	Hypothesis											
Occupation and Service	+	+	+	+	(+)	?	?	?	?	?	(−)	−
Estimates for DoD-OCC 041: Artillery and Gunnery												
16R (Army)	+	(−)	+	(+)	(−)	(+)	(+)	(+)	(−)	(+)	(+)	−
GMG (Navy)	(+)	(+)	+	+	+	(−)	(−)	(−)	(+)	(−)	(−)	(−)
0811 (Marines)	(−)	+	(+)	(+)	(+)	(−)	(−)	(+)	(+)	(+)	(+)	(−)
Estimates for DoD-OCC 102: Navigation, Communication and Countermeasure												
33S (Army)	underidentified											
AX (Navy)[a]	(−)	(−)	(+)	+	(+)	(+)	+	−	−	(+)	(−)	(−)
CTM (Navy)[a]	(−)	(−)	(+)	(−)	(−)	+	(+)	(−)	−	(−)	(−)	n.a.
AF-COMB[a]	(+)	(+)	(+)	+	+	(+)	(+)	(−)	(−)	−	(−)	(−)
Estimates for DoD-OCC 160: Teletype and Cryptographic Equipment, General												
31S (Army)	+	(+)	+	(+)	+	(+)	n.a.	(+)	(+)	(+)	(−)	(−)
Estimates for DoD-OCC 222: Air Traffic Control												
93H (Army)	(+)	(−)	−	(+)	(+)	(−)	(−)	(+)	(−)	(−)	−	n.a.
AC (Navy)	−	(+)	+	(−)	(+)	(+)	−	(+)	(+)	(+)	(−)	n.a.
7322 (Marines)	(+)	(−)	+	(−)	(+)	(+)	(−)	(−)	(+)	n.a.	(−)	n.a.
272×0 (AF)	(+)	(−)	+	(−)	(+)	(+)	(−)	(−)	(+)	−	(−)	n.a.
Estimates for DoD-OCC 232: Analysis												
98C (Army)	−	−	+	+	+	(+)	(+)	+	+	(+)	n.a.	n.a.
CTI (Navy)	−	(+)	(−)	(+)	(+)	n.a.	(+)	(−)	(+)	(+)	(−)	(−)
202×0 (AF)	(+)	(+)	(+)	−	(+)	(−)	(−)	n.a.	n.a.	n.a.	n.a.	n.a.

[a]These Navy ratings contain some six-year obligors.

[b]"Air Force Combined," 304×1, 328×1, 328×3, 328×4.

same year they were fired by President Reagan. As a consequence, many military air traffic controllers chose to leave their respective services at the next opportunity to be hired as replacements for the controllers that were fired.

The bonus managers in the Navy, Air Force, and Marines did not react to this shock. The bonuses offered by these three services in the half-year from April 1981 through September 1981 remained the same as they were in the previous half-year (Marines) or had been for the past three years (Navy and Air Force). As a consequence, the exogenous shock of large numbers of servicemembers leaving during this period in reaction to the air traffic controllers' strike is largely absorbed by the random error term. The coefficients of the bonus variables are only marginally affected. Only the bonus managers for the Army reacted by quadrupling the bonus step for air traffic controllers during this half-year. In spite of this, many Army air traffic controllers whose ETS came up in this half-year decided to leave the service. As a consequence, the outlier caused by the exogenous shock is associated with the historically highest bonus ever offered to Army air traffic controllers. The result is a set of perverse bonus effects estimated for this specialty.[8]

Apart from this exception, most of the coefficient estimates have the expected sign and a fair number are significant at the 95 percent level. During the crucial ETS period, for example, all the significant coefficients have the expected sign, and only one insignificant coefficient has the wrong sign.

In the periods before the ETS period, the results are not quite as clear. The plus signs still predominate, although there are a number of occupations where a lead effect of the bonus cannot be identified.[9] For some specialties, bonuses even appear to *reduce* the continuation rates toward the end of the first term (increase attrition). One possible explanation is that in some specialties SRBs were used in conjunction with tighter qualification requirements in an attempt to improve the quality of the personnel retained.

In the two periods immediately after the first ETS, bonus effects are generally positive. There is only one significant coefficient that has the wrong sign. Seven coefficients have the expected positive signs, and counting significant and insignificant coefficient estimates alike, the positive signs outnumber the negative signs by better than two to one.

It is possible that the negative and insignificant effects for periods 1 and 2 are partly due to a feature of the bonus system that in effect allows servicemembers to maximize the bonus they receive by timing their reenlistment decision. A servicemember approaching his ETS

[8]Note that the coefficients for the later periods are unaffected. To have made it to period 4 within the observation period, an individual must have had his or her ETS before April 1981. Although these individuals may still be affected by the exogenous shock of the strike, the shock for them is not associated with an outlier on the bonus variable, and the estimated bonus coefficients remain essentially unaffected.

[9]This specification, with the actual bonus included as a measure for "expected bonus," assumes a perfect foresight or rational expectations type model. Alternative specifications using adaptive expectations models were also run for some specialties, without significantly altering the results.

may well have a fairly good idea of whether he might be eligible for a higher bonus if he were to reenlist at a later point.[10] If this is the case, he may choose to extend, rather than reenlist, and to reenlist at the end of his extension, after SRBs have been increased. Service directives detailing conditions for granting extensions have recently been tightened by restricting permissible "personal reasons," but over the time horizon of our data they were unable to completely control individuals gaming the system. In the model presented here, an individual extending to reenlist later at a higher bonus would be coded as having continued his service past his ETS, and not receiving a bonus. His actual reenlistment, with a bonus, at the end of the extension is not considered here. As a result, the proportion of individuals continuing service in periods 1 and 2, apparently without a bonus, is slightly overestimated, and as a consequence, the effect of the bonus in increasing retention in periods 1 and 2 may be underestimated.

This downward bias would of course be strongest for specialties that experienced a general upward trend in bonus steps over the observation period. Indeed, bonus steps for PMOS 202×0, 272×0, 7322, and AC trended upward between 1976 and 1983.[11] Only the Navy rating CTM shows negative bonus effects for periods 1 and 2 despite the fact that bonus steps showed no particular trend over the observation period.

Probably the most important result, however, is the clear demonstration that individuals who were induced by bonuses to continue in the service after their first ETS have a lower propensity to reenlist at the second ETS. The pattern of negative signs for periods 8 and 9 shows this very clearly. Models that do not take this lag effect of SRBs into account will probably overestimate the effectiveness of bonuses in augmenting the career force. The importance of this effect in estimating additional man-years of service generated through bonuses has been discussed in Section II, and the quantitative impact can be seen from the survivor functions discussed in the next subsection.

SURVIVOR FUNCTIONS

The overall effect of the different coefficients on the retention profile or the survivor function for individual specialties is difficult to determine from the coefficients given in Appendix Table A.1. How much the continuation rate in a particular period changes in response

[10]Services announce bonus changes 30 days before their effective date. However, speculation and rumors about impending bonus changes are often heard much earlier.

[11]See Appendix C.

to a change in the bonus step depends not only on the bonus coefficient, but also on the underlying basic continuation rate, i.e., the point of evaluation. Matters are made even more difficult by the double logarithmic transformation used to remove range constraints on the coefficient estimates.

Conditional continuation rates for each of the 12 periods can be readily calculated for any arbitrary bonus step using Eqs. (9) and (15). By multiplying out these continuation rates the (unconditional) survivor functions for any bonus step and any combination of personal and environmental conditions can be constructed. Tables 2a and 2b present the results for the three combat specialties included in this analysis; the corresponding tables for all the 15 specialties can again be found in Appendix A.

The continuation rates and survivor functions were calculated for a hypothetical individual with mean characteristics facing the average bonus step observed over the sample, as well as at an SRB one step higher.[12] In Figs. 2 through 4, survivor functions obtained in this manner are plotted for the three combat specialties. In addition to the survivor functions shown in Table 2, survivor functions at SRBs one step lower and three steps higher than the sample average are also plotted. The corresponding graphs for the remaining 12 specialties can be found in Appendix B.

The separate effects that the bonus has on the different periods are now clearly visible. It is also clear that even though the overall pattern is similar, the size of the bonus effects varies considerably from specialty to specialty. This last point will be discussed in more detail in the section on bonus improvement factors.

[12]Since the underlying model is distinctly nonlinear, the survivor functions for an individual with mean characteristics does not reflect the mean survivor function for the entire sample. The extent of the deviation depends on the distribution of the other explanatory variables. To arrive at a measure of the mean bonus response, survivor functions for each type of individual in a cohort would have to be constructed and the results averaged over the population, using the frequency of each type of individual in the population as averaging weights.

Table 2a

CONTINUATION RATES AND SURVIVOR FUNCTIONS
(Unadjusted)

Occupation and Service	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
PMOS 16R (Army)												
Continuation rate												
at avg. bonus (1.21)	0.974	0.958	0.518	0.928	0.976	0.968	0.980	0.956	0.974	0.949	0.961	0.978
at avg. bonus +1	0.991	0.972	0.567	0.938	0.976	0.958	0.977	0.947	0.971	0.952	0.949	0.953
Survivor function												
at avg. bonus (1.21)	0.974	0.934	0.484	0.449	0.439	0.425	0.416	0.398	0.387	0.368	0.354	0.346
at avg. bonus +1	0.991	0.963	0.546	0.512	0.500	0.479	0.468	0.443	0.430	0.410	0.389	0.370
PMOS GMG (Navy)												
Continuation rate												
at avg. bonus (1.20)	0.980	0.964	0.357	0.876	0.953	0.969	0.977	0.963	0.967	0.944	0.903	0.972
at avg. bonus +1	0.990	0.978	0.448	0.898	0.963	0.971	0.976	0.964	0.971	0.942	0.905	0.958
Survivor function												
at avg. bonus (1.20)	0.930	0.945	0.337	0.296	0.282	0.273	0.267	0.257	0.248	0.234	0.212	0.206
at avg. bonus +1	0.989	0.968	0.433	0.389	0.375	0.364	0.355	0.342	0.332	0.313	0.283	0.271
PMOS 0811 (Marines)												
Continuation rate												
at avg. bonus (.552)	0.955	0.956	0.386	0.805	0.918	0.951	0.960	0.924	0.922	0.930	0.935	0.946
at avg. bonus +1	0.954	0.970	0.393	0.822	0.932	0.960	0.956	0.940	0.926	0.932	0.951	0.939
Survivor function												
at avg. bonus (.552)	0.955	0.913	0.353	0.284	0.261	0.248	0.238	0.220	0.202	0.188	0.176	0.167
at avg. bonus +1	0.954	0.926	0.364	0.299	0.279	0.268	0.256	0.241	0.223	0.208	0.198	0.186

Table 2b

CONTINUATION RATES AND SURVIVOR FUNCTIONS
(Adjusted for eligibility)

Occupation and Service	Period –2	–1	0	1	2	3	4	5	6	7	8	9
PMOS 16R (Army)												
Continuation rate												
at avg. bonus (1.21)	0.999	0.998	0.647	0.957	0.992	0.995	0.997	0.979	0.991	0.977	0.978	0.997
at avg. bonus +1	0.999	0.998	0.691	0.958	0.990	0.996	0.998	0.979	0.985	0.978	0.979	0.987
Survivor function												
at avg. bonus (1.21)	0.999	0.998	0.646	0.619	0.614	0.611	0.610	0.597	0.592	0.579	0.566	0.564
at avg. bonus +1	0.999	0.998	0.690	0.661	0.655	0.653	0.652	0.638	0.629	0.616	0.603	0.596
PMOS GMG (Navy)												
Continuation rate												
at avg. bonus (1.20)	0.997	0.983	0.413	0.904	0.973	0.983	0.989	0.991	0.979	0.967	0.924	0.993
at avg. bonus +1	0.997	0.988	0.492	0.919	0.980	0.982	0.987	0.985	0.979	0.960	0.920	0.981
Survivor function												
at avg. bonus (1.20)	0.997	0.980	0.405	0.366	0.357	0.351	0.347	0.344	0.337	0.326	0.301	0.299
at avg. bonus +1	0.997	0.986	0.486	0.447	0.438	0.431	0.425	0.419	0.411	0.394	0.363	0.356
PMOS 0811 (Marines)												
Continuation rate												
at avg. bonus (0.55)	0.955	0.955	0.386	0.804	0.918	0.950	0.959	0.923	0.921	0.929	0.935	0.945
at avg. bonus +1	0.954	0.969	0.393	0.821	0.932	0.960	0.956	0.940	0.925	0.932	0.950	0.939
Survivor function												
at avg. bonus (0.55)	0.955	0.912	0.352	0.283	0.260	0.247	0.237	0.219	0.202	0.188	0.176	0.166
at avg. bonus +1	0.954	0.925	0.364	0.299	0.278	0.267	0.256	0.240	0.222	0.207	0.197	0.185

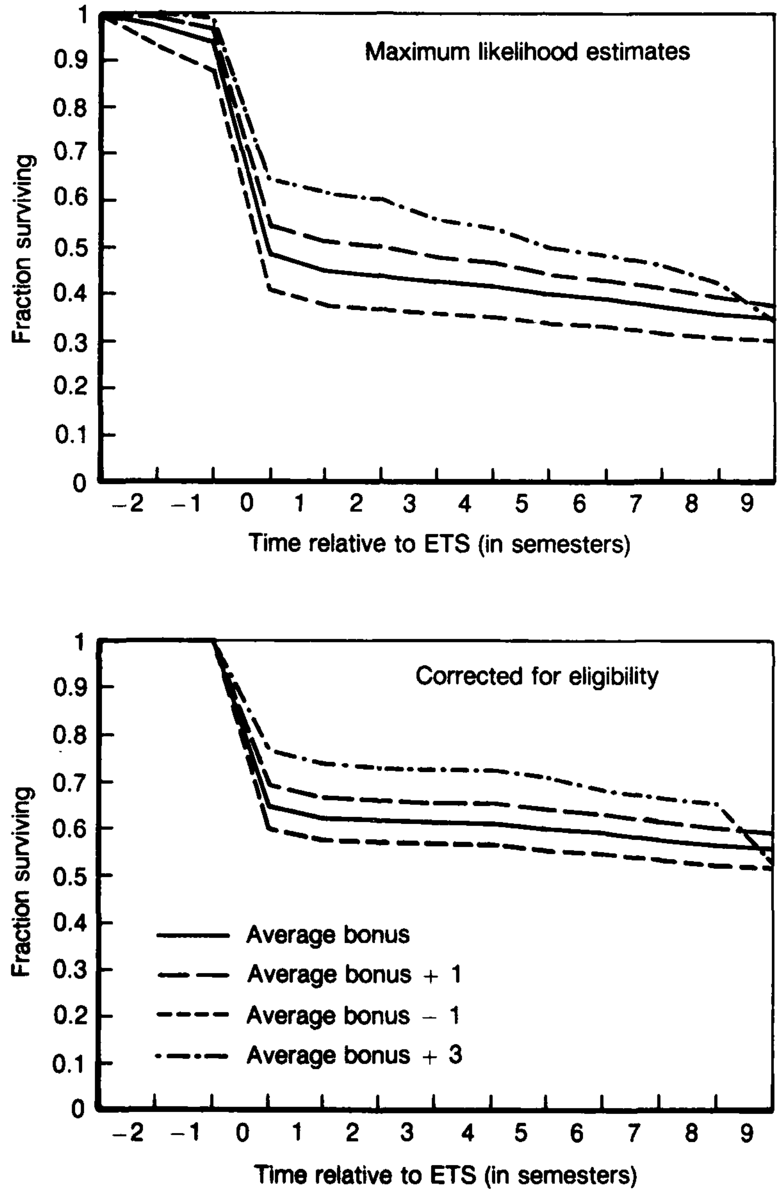

Fig. 2—Survivor function PMOS 16R

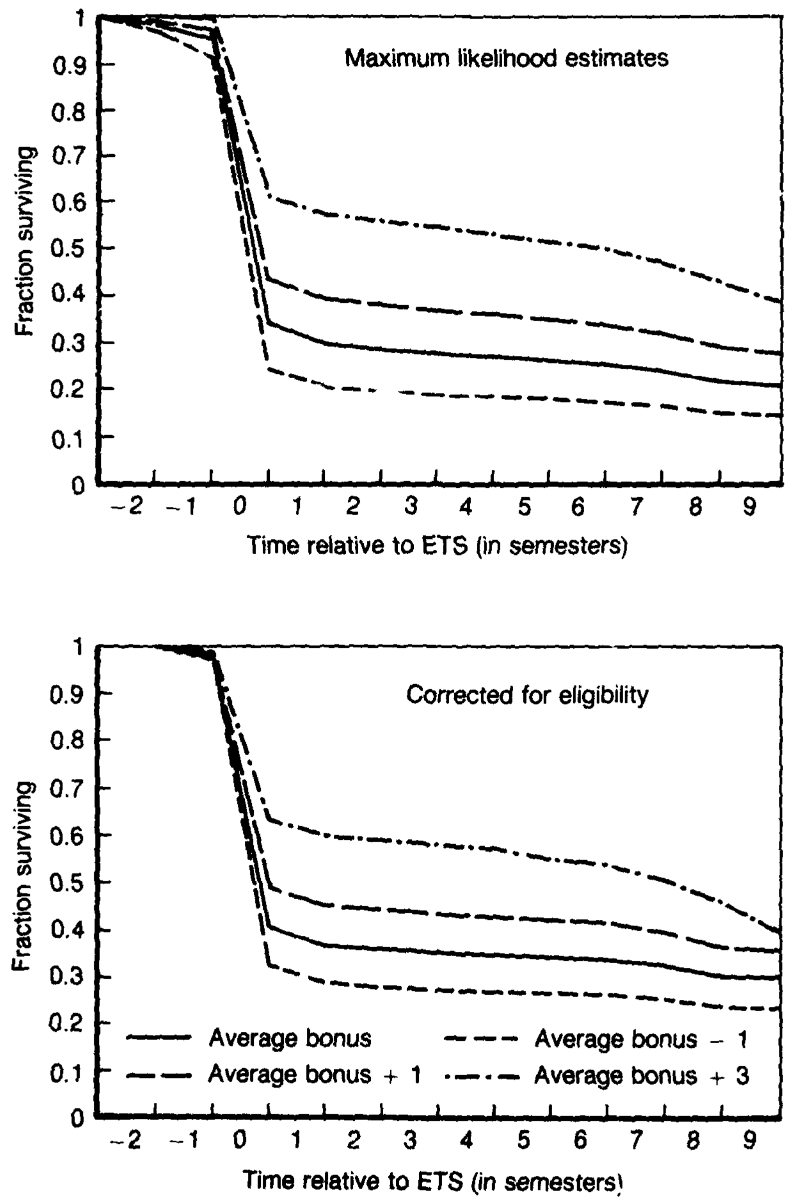

Fig. 3—Survivor function PMOS GMG

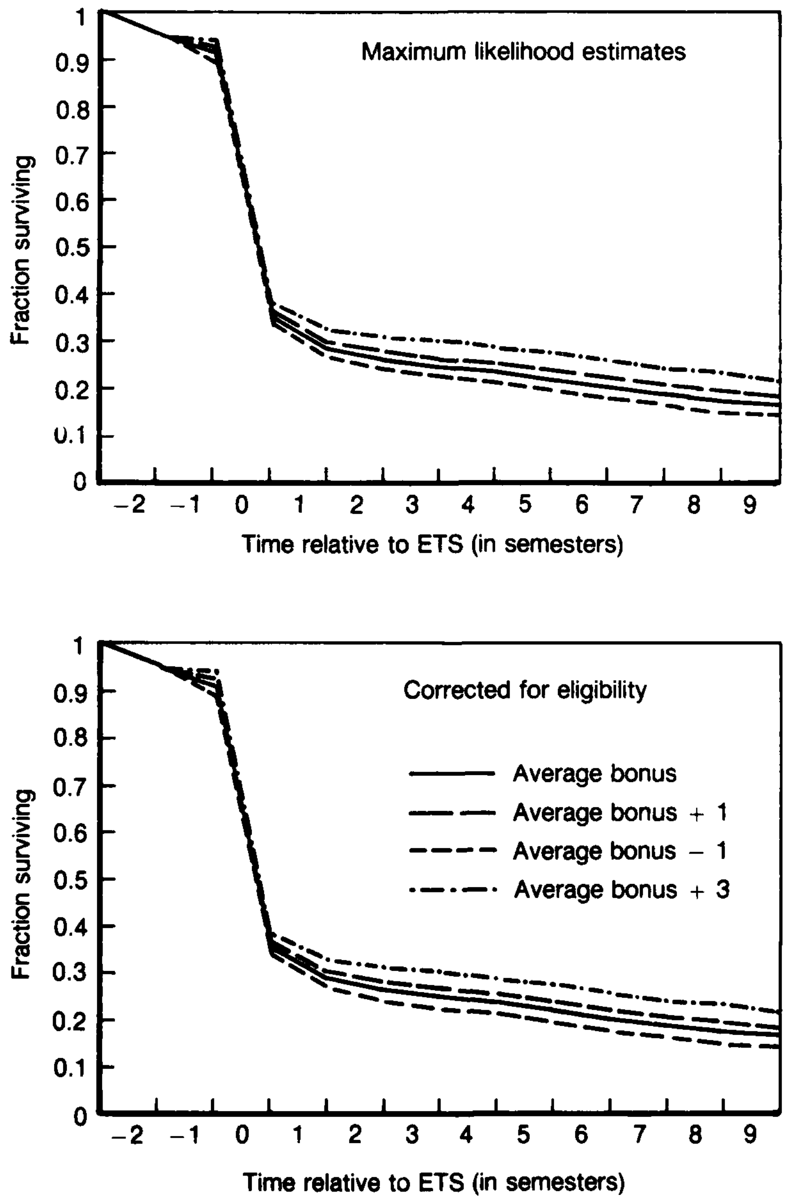

Fig. 4—Survivor function PMOS 0811

IV. BONUS IMPROVEMENT FACTORS

Most bonus improvement factors that have been estimated are concerned solely with the increase in retention at the ETS point. Some studies go one step further and distinguish between extensions and reenlistments (Hosek and Peterson [1985]). However, the lead effects in periods prior to the ETS and the lag effects at the end of the second term have never been fully quantified.

The lagged effect of a first-term reenlistment bonus on retention at the second ETS has been an especially contentious issue. Warner and Simon [1979], Rodney [1980], and for the Air Force Hiller [1981] found that a first-term bonus did indeed lead to reduced reenlistment rates at the second ETS. But Kleinman and Shugart [1974], and for the Army, Navy, and Marine Corps, Hiller [1981] found no such effect.

This issue can obviously not be analyzed with cross-sectional data on individuals reaching their first ETS. Even a cross-section of servicemembers at their second ETS may not provide all the necessary information. If individuals who were induced by a bonus to sign up for a second term have a lower than average taste for the military, they are also more likely to seize an early out option once the opportunity presents itself, and thus never reach the second ETS.

The survivor function model that analyzes the effect of SRBs on continuation rates in every period seems to be the most appropriate model for evaluating the overall effect of bonuses on man-years served. By also providing estimates for what could be termed "partial" bonus improvement factors, particularly the period-specific bonus improvement factor for period 0, it also offers the opportunity for comparing the results and gauging the extent of potential biases.

PERIOD-SPECIFIC FACTORS

Tables 3a through 3d present the estimated period-specific bonus improvement factors and the bonus elasticities evaluated at the sample means. The first two tables present estimates based on point elasticities evaluated at the average bonus step, while Tables 3c and 3d give the corresponding estimates based on the arc elasticity concept. For most specialties and most periods the difference between the two measures is quite small. However, in those instances where continuation rates approach one (e.g., period −2), the approximation provided by the point estimates can become quite imprecise. Furthermore, when man-year effects are considered, these approximation errors are compounded. For changes in the bonus of one full step or more, the arc elasticity-based measures probably provide a more accurate approximation, and in the remainder of this study only the bonus effects based on the improvement factors in Tables 3c and 3d will be reported.

The measure most directly related to the traditional definition of bonus improvement factors is the bonus improvement factor for period 0. As can be seen, it is positive for all occupations considered here, except for air traffic controllers in the Army and intelligence analysts in the Navy. In the case of the Navy, the corresponding coefficient estimate is insignificant, and the perverse sign in the Army case was explained in Section III.

However, the period 0 bonus improvement factor does not capture the increase in retention before the first ETS because of the expectation of a bonus. That this effect is operating can be seen by the positive bonus improvement factors for periods -1 and -2. As would be expected, this lead effect is not quite as strong as the main bonus effect at the first ETS. For the eligibility adjusted estimates, this effect is almost nil, primarily because individuals leaving before their ETS usually have an ISC larger than 1 on their exit records.

The bonus improvement factors for the periods after the first ETS are also quite small compared with the main effect in period 0. This should not be surprising. The generally positive signs of these bonus improvement factors reflect the shift from extensions to reenlistments that is brought about by the bonus. Hosek and Peterson [1985] have also observed such an effect.

The period 9 bonus improvement factors have the expected signs for all the occupations for which this coefficient could be estimated. With three exceptions, all of them are statistically insignificant, this also holds for period 8. However, for most specialties, this effect is not quite as large as might have been expected, perhaps partly because this prototype model does not take into account bonuses offered at the second reenlistment point. Future versions will have to account for this.

The bonus improvement factors for period 0 are quite close to other estimates reported in the literature,[1] despite the fact that the improvement factors reported in Table 3 refer to improvements in the overall continuation rates. They reflect the combined increases in reenlistment and extension rates. If bonuses induce servicemembers to reenlist, rather than extend, reenlistment rates will go up, while extension

[1]See, for example, the compilation of estimated bonus improvement factors in Lakhani and Gilroy [1984].

Table 3a

PERIOD-SPECIFIC BONUS IMPROVEMENT FACTORS
(Point estimates)

Occupation and Service (PMOS)	Period -2	-1	0	1	2	3	4	5	6	7	8	9
Artillery and Gunnery												
Army (16R)	.026[a]	.017	.096	.012	-.000	-.009	-.003	-.009	-.003	.003	-.011	-.017
	(.032)	(.020)	(.117)	(.014)	(-.000)	(-.011)	(-.004)	(-.010)	(-.003)	(.003)	(-.014)	(-.021)
Navy (GMG)	.013	.019	.255	.028	.012	.002	-.001	.001	.004	-.001	.002	-.012
	(.015)	(.022)	(.307)	(.033)	(.014)	(.002)	(-.001)	(.002)	(.005)	(-.002)	(.003)	(-.014)
Marines (0811)	-.001	.018	.018	.022	.016	.011	-.003	.020	.004	.003	.019	-.007
	(-.001)	(.010)	(.010)	(.012)	(.009)	(.006)	(-.002)	(.011)	(.002)	(.002)	(.010)	(-.004)
Teletype and Cryptographic Equipment, General												
Army (31S)	.015	.006	.132	.046	.028	.003	.000	.012	-.001	.017	-.010	-.005
	(.013)	(.006)	(.117)	(.041)	(.024)	(.002)		(.011)	(-.001)	(.015)	(-.009)	(-.005)
Air Traffic Control												
Army (93H)	-.003	-.005	-.071	.001	-.001	.002	-.005	.012	-.009	-.007	-.038	n.a.
	(-.005)	(-.008)	(-.120)	(.001)	(-.001)	(.004)	(-.009)	(.020)	(-.016)	(-.007)	(-.065)	n.a.
Navy (AC)	-.004	.004	.100	-.009	-.005	.002	.004	.008	.006	.009	-.008	n.a.
	(-.019)	(.018)	(.420)	(-.037)	(-.022)	(.009)	(.018)	(.035)	(.024)	(.037)	(-.033)	n.a.
Marines (7322)	.004	-.004	.144	-.008	.010	.007	-.026	-.007	.021	.000	n.a.	n.a.
	(.014)	(-.015)	(.563)	(-.033)	(.038)	(.028)	(-.103)	(-.026)	(.082)		n.a.	n.a.
Air Force (272×0)	.000	-.024	.048	-.006	.002	-.013	.007	.012	.025	.005	-.064	n.a.
	(.001)	(-.087)	(.175)	(-.022)	(.009)	(-.047)	(.025)	(.044)	(.091)	(.018)	(-.232)	n.a.

Table 3a—(continued)

Occupation and Service (PMOS)		Period -2	-1	0	1	2	3	4	5	6	7	8	9
Analysis													
Army	(98C)	-.003	-.004	.086	.038	.019	.008	.006	.010	.016	.013	n.a.	n.a.
		(-.004)	(-.006)	(.129)	(.057)	(.029)	(.012)	(.009)	(.015)	(.023)	(.020)	n.a.	n.a.
Navy	(CTI)	-.003	.007	-.045	.040	.022	.000	.008	-.008	.026	.011	-.019	-.040
		(-.006)	(.013)	(-.091)	(.082)	(.045)		(.016)	(-.016)	(.053)	(.023)	(-.038)	(-.081)
Air Force	(202×0)	.005	.001	.066	-.034	.030	-.030	-.006	n.a.	n.a.	n.a.	n.a.	n.a.
		(.004)	(.001)	(.045)	(-.023)	(.021)	(-.021)	(-.004)	n.a.	n.a.	n.a.	n.a.	n.a.
Navigation, Communication and Countermeasure, n.e.c.													
Army	(33S)	-.002	-.003	.088	.010	.010	.004	-.003	.002	-.009	-.011	.022	n.a.
		(-.004)	(-.005)	(.171)	(.018)	(.018)	(.008)	(-.007)	(.003)	(-.017)	(-.021)	(.042)	n.a.
Navy	(AX)	.004	.001	.069	.016	.013	.013	.028	-.003	-.017	.001	-.022	-.034
		(.008)	(.001)	(.124)	(.023)	(.023)	(.023)	(.051)	(-.006)	(-.030)	(.002)	(-.034)	(-.013)
Navy	(CTM)	-.010	-.000	.074	-.007	-.010	.016	.006	-.001	-.038	-.006	-.021	n.a.
		(-.034)	(-.001)	(.277)	(-.026)	(-.039)	(.060)	(.022)	(-.004)	(-.143)	(-.023)	(-.079)	n.a.
Air Force	(COMB)	.003	.005	.005	.019	.024	.013	.010	-.007	-.021	-.020	-.011	-.006
		(.003)	(.004)	(.004)	(.017)	(.022)	(.012)	(.009)	(-.006)	(-.019)	(-.018)	(-.010)	(-.006)

[a]Elasticities at average SRB step in parentheses.

Table 3b

PERIOD-SPECIFIC BONUS IMPROVEMENT FACTORS
(Point estimates corrected for eligibility)

Occupation and Service (PMOS)	Period −2	−1	0	1	2	3	4	5	6	7	8	9
Artillery and Gunnery												
Army (16R)	.000[a]	-.000	.071	.001	-.002	.001	.001	.001	-.004	.001	.001	-.004
	(.000)	(-.000)	(.086)	(.002)	(-.002)	(.001)	(.001)	(.001)	(-.005)	(.001)	(.002)	(-.005)
Navy (GMG)	.001	.006	.195	.018	.009	-.000	-.002	-.004	.000	-.007	-.004	-.007
	(.001)	(.007)	(.235)	(.022)	(.011)	(-.000)	(-.002)	(-.005)	(.000)	(-.009)	(-.004)	(-.008)
Marines (0811)	-.001	.018	.018	.022	.016	.011	-.003	.020	.004	.003	.019	-.007
	(-.001)	(.010)	(.010)	(.012)	(.009)	(.006)	(-.002)	(.011)	(.002)	(.002)	(.010)	(-.004)
Teletype and Cryptographic Equipment, General												
Army (31S)	.000	.000	.079	.022	.000	.000	.000	.007	.003	.007	-.012	-.008
	(.000)	(.070)	(.019)		(.000)		(.006)	(.003)	(.006)	(-.011)	(-.007)	
Air Traffic Control												
Army (93H)	.001	-.001	-.051	.003	.000	.000	-.001	.006	-.007	-.001	-.034	n.a.
	(.001)	(-.002)	(-.086)	(.004)	(.000)		(-.002)	(.010)	(-.011)	(-.001)	(-.057)	n.a.
Navy (AC)	-.001	.000	.064	-.005	.000	.003	.000	.005	.004	.003	-.007	n.a.
	(-.004)	(.000)	(.272)	(-.019)	(.000)	(.011)		(.021)	(.017)	(.013)	(-.029)	n.a.
Marines (7322)	.000	-.001	.112	-.011	.008	.006	-.012	-.004	.021	.000	n.a.	n.a.
	(.000)	(-.003)	(.437)	(-.044)	(.030)	(.024)	(-.047)	(-.015)	(.080)		n.a.	n.a.
Air Force (272×0)	-.001	.000	-.011	.002	.006	-.005	.009	.005	.017	-.031	-.009	n.a.
	(-.002)		(-.041)	(.006)	(.020)	(-.017)	(.034)	(.017)	(.063)	(-.111)	(-.034)	n.a.

Table 3b—(continued)

Occupation and Service (PMOS)		Period											
		−2	−1	0	1	2	3	4	5	6	7	8	9
Analysis													
Army	(98C)	-.001	-.001	.033	.020	.011	.002	.000	.002	.000	.005	n.a.	n.a.
		(-.001)	(-.002)	(.049)	(.031)	(.016)	(.003)	(.000)	(.004)		(.008)	n.a.	n.a.
Navy	(CTI)	.000	.007	-.099	.019	-.011	.000	.004	.000	.005	.000	.001	-.025
		(-.000)	(.015)	(-.202)	(.039)	(-.022)		(.009)	(-.000)	(.012)	(.000)	(.002)	(-.051)
Air Force	(202×0)	-.001	.000	.036	-.018	.011	-.012	-.007	n.a.	n.a.	n.a.	n.a.	n.a.
		(-.001)	(.000)	(.025)	(-.012)	(.008)	(-.008)	(-.005)	n.a.	n.a.	n.a.	n.a.	n.a.
Navigation, Communication and Countermeasure, n.e.c.													
Army	(33S)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Navy	(AX)	-.001	-.004	.037	.015	.012	.009	.028	.000	-.015	.005	-.022	-.009
		(-.002)	(-.008)	(.067)	(.027)	(.022)	(.016)	(.051)		(-.027)	(.009)	(-.040)	(-.016)
Navy	(CTM)	-.000	-.007	.052	-.000	-.008	.016	.011	-.001	-.038	-.006	-.012	n.a.
		(-.000)	(-.026)	(.195)	(-.000)	(-.031)	(.059)	(.041)	(-.004)	(-.143)	(-.023)	(-.045)	n.a.
Air Force	(COMB)	.000	.000	.010	.016	.015	.001	.014	-.001	-.010	-.019	-.015	-.008
		(.000)	(.000)	(.010)	(.014)	(.014)	(.001)	(.013)	(-.001)	(-.010)	(-.017)	(-.014)	(-.007)

Table 3c

PERIOD-SPECIFIC BONUS IMPROVEMENT FACTORS
(Arc estimates)

Occupation and Service (PMOS)	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
Artillery and Gunnery												
Army (16R)	.017	.014	.094	.011	−.000	−.010	−.003	−.009	−.003	.003	−.013	−.025
	(.020)	(.017)	(.113)	(.013)	(−.000)	(−.012)	(−.004)	(−.011)	(−.004)	(.003)	(−.016)	(−.031)
Navy (GMG)	.009	.015	.254	.025	.010	.002	−.001	.001	.004	−.001	.002	−.015
	(.011)	(.018)	(.305)	(.030)	(.013)	(.002)	(−.001)	(.001)	(.005)	(−.002)	(.003)	(−.018)
Marines (0811)	−.001	.015	.019	.021	.015	.010	−.004	.018	.004	.003	.017	−.007
	(−.001)	(.008)	(.010)	(.012)	(.008)	(.006)	(−.002)	(.010)	(.002)	(.002)	(.009)	(−.004)
Teletype and Cryptographic Equipment, General												
Army (31S)	.009	.005	.126	.028	.017	.002	−.000	.011	−.001	.014	−.011	−.006
	(.008)	(.004)	(.111)	(.025)	(.015)	(.002)	(−.000)	(.009)	(−.001)	(.012)	(−.010)	(−.005)
Air Traffic Control												
Army (93H)	−.003	−.006	−.075	.001	−.001	.002	−.007	.010	−.012	−.008	−.062	n.a.
	(−.005)	(−.011)	(−.126)	(.001)	(−.001)	(.003)	(−.012)	(.017)	(−.020)	(−.013)	(−.105)	n.a.
Navy (AC)	−.005	.004	.097	−.009	−.006	.002	.004	.006	.005	.006	−.008	n.a.
	(−.021)	(.017)	(.409)	(−.039)	(−.023)	(.009)	(.017)	(.025)	(.020)	(.024)	(−.035)	n.a.
Marines (7322)	.003	−.005	.135	−.009	.008	.006	−.032	−.007	.017	.000	n.a.	n.a.
	(.011)	(−.018)	(.527)	(−.035)	(.029)	(.025)	(−.123)	(−.027)	(.066)	(.000)	n.a.	n.a.
Air Force (272×0)	.000	−.029	.047	−.006	.002	−.014	.006	.011	.020	.005	−.075	n.a.
	(.001)	(−.105)	(.173)	(−.022)	(.009)	(−.053)	(.022)	(.039)	(.072)	(.018)	(−.275)	n.a.

Table 3c—(continued)

Occupation and Service (PMOS)		Period											
		−2	−1	0	1	2	3	4	5	6	7	8	9
Analysis													
Army	(98C)	−.003	−.004	.084	.033	.017	.007	.005	.006	.010	.012	n.a.	n.a.
		(−.004)	(−.006)	(.126)	(.049)	(.025)	(.010)	(.008)	(.010)	(.015)	(.018	n.a.	n.a.
Navy	(CTI)	−.004	.006	−.045	.034	.020	−.000	.007	−.009	.022	.008	−.021	−.056
		(−.008)	(.012)	(−.092)	(.070)	(.041)	(−.000)	(.014)	(−.018)	(.044)	(.017)	(−.043)	(−.115)
Air Force	(202×0)	.005	.001	.064	−.041	.024	−.040	−.007	n.a.	n.a.	n.a.	n.a.	n.a.
		(.003)	(.001)	(.044)	(−.028)	(.016)	(−.027)	(−.005)	n.a.	n.a.	n.a.	n.a.	n.a.
Navigation, Communication and Countermeasure, n.e.c.													
Army	(33S)	−.003	−.003	.087	.009	.008	.003	−.004	.001	−.009	−.012	.020	n.a.
		(−.005)	(−.006)	(.168)	(.018)	(.016)	(.007)	(−.007)	(.003)	(−.018)	(−.023)	(.038)	n.a.
Navy	(AX)	.004	.001	.068	.015	.012	.010	.025	−.003	−.021	.001	−.027	−.007
		(.007)	(.001)	(.123)	(.027)	(.021)	(.018)	(.046)	(−.006)	(−.038)	(.002)	(−.049)	(−.013)
Navy	(CTM)	−.017	−.000	.071	−.007	−.012	.012	.006	−.001	−.062	−.007	−.024	n.a.
		(−.065)	(−.001)	(.265)	(−.028)	(−.045)	(.045)	(.021)	(−.004)	(−.233)	(−.026)	(−.090)	n.a.
Air Force	(COMB)	.003	.005	.005	.017	.021	.011	.009	−.008	−.023	−.024	−.012	−.007
		(.003)	(.004)	(.004)	(.016)	(.019)	(.010)	(.008)	(−.007)	(−.021)	(−.021)	(−.011)	(−.006)

Table 3d

PERIOD-SPECIFIC BONUS IMPROVEMENT FACTORS
(Arc estimates, adjusted for eligibility)

Occupation and Service (PMOS)	Period -2	-1	0	1	2	3	4	5	6	7	8	9
Artillery and Gunnery												
Army (16R)	.000	-.000	.068	.001	-.002	.001	.001	.001	-.006	.001	.001	-.009
	(.000)	(-.000)	(.082)	(.002)	(-.002)	(.001)	(.001)	(.001)	(-.007)	(.001)	(.002)	(-.011)
Navy (GMG)	.001	.005	.191	.017	.008	-.000	-.002	-.005	.000	-.008	-.004	-.012
	(.001)	(.006)	(.230)	(.020)	(.009)	(-.000)	(-.002)	(-.007)	(.000)	(-.010)	(-.005)	(-.015)
Marines (0811)	-.001	.015	.019	.021	.015	.010	-.004	.018	.004	.003	.017	-.007
	(-.001)	(.008)	(.010)	(.012)	(.008)	(.006)	(-.002)	(.010)	(.002)	(.002)	(.009)	(-.004)
Teletype and Cryptographic Equipment, General												
Army (31S)	-.000	.000	.074	.013	-.000	.000	.000	.006	.003	.006	-.014	-.009
	(-.000)	(.000)	(.065)	(.012)	(-.000)	(.000)	(.000)	(.006)	(.003)	(.006)	(-.013)	(-.008)
Air Traffic Control												
Army (93H)	.001	-.002	-.054	.002	.000	-.000	-.001	.005	-.010	-.001	-.059	n.a.
	(.001)	(-.004)	(-.091)	(.004)	(.000)	(-.000)	(-.002)	(.009)	(-.017)	(-.001)	(-.100)	n.a.
Navy (AC)	-.001	.000	.063	-.005	.000	.002	.000	.004	.003	.002	-.007	n.a.
	(-.005)	(.000)	(.266)	(-.020)	(.000)	(.010)	(.000)	(.015)	(.014)	(.007)	(-.030)	n.a.
Marines (7322)	.000	-.001	.102	-.012	.005	.005	-.015	-.004	.016	.000	n.a.	n.a.
	(.000)	(-.004)	(.400)	(-.048)	(.020)	(.020)	(-.060)	(-.016)	(.063)	(.000)	n.a.	n.a.
Air Force (272×0)	-.001	-.000	-.011	.002	.005	-.005	.007	.004	.012	-.036	-.010	n.a.
	(-.002)	(-.000)	(-.041)	(.006)	(.019)	(-.020)	(.024)	(.015)	(.044)	(-.130)	(-.035)	n.a.

Table 3d—(continued)

Occupation and Service (PMOS)		Period											
		−2	−1	0	1	2	3	4	5	6	7	8	9
Analysis													
Army	(98C)	−.001	−.002	.032	.018	.009	.002	.000	.002	−.000	.004	n.a.	n.a.
		(−.001)	(−.002)	(.048)	(.026)	(.014)	(.003)	(.000)	(.003)	(−.000)	(.007)	n.a.	n.a.
Navy	(CTI)	−.000	.006	−.101	.018	−.011	−.000	.004	−.000	.005	.000	.001	−.035
		(−.000)	(.013)	(−.207)	(.036)	(−.023)	(−.000)	(.008)	(−.000)	(.010)	(.000)	(.002)	(−.071)
Air Force	(202×0)	−.002	.000	.035	−.024	.010	−.016	−.009	n.a.	n.a.	n.a.	n.a.	n.a.
		(−.001)	(.000)	(.024)	(−.017)	(.007)	(−.011)	(−.006)	n.a.	n.a.	n.a.	n.a.	n.a.
Navigation, Communication and Countermeasure, n.e.c.													
Army	(33S)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Navy	(AX)	−.001	−.005	.037	.013	.011	.007	.025	.000	−.020	.005	−.027	−.010
		(−.002)	(−.009)	(.066)	(.024)	(.020)	(.012)	(.044)	(.000)	(−.036)	(.008)	(−.049)	(−.018)
Navy	(CTM)	−.000	−.008	.050	−.000	−.009	.011	.010	−.001	−.062	−.007	−.013	n.a.
		(−.000)	(−.030)	(.188)	(−.000)	(−.034)	(.041)	(.038)	(−.004)	(−.232)	(−.026)	(−.049)	n.a.
Air Force	(COMB)	.000	.000	.010	.014	.013	.001	.011	−.001	−.011	−.023	−.018	−.009
		(.000)	(.000)	(.009)	(.013)	(.012)	(.001)	(.010)	(−.001)	(−.010)	(−.021)	(−.016)	(−.008)

rates fall. In this case, the net increase in continuation rates would be less than the increase in reenlistments.

To obtain a better appreciation of the effect of an increase in the SRB step on reenlistments, it is necessary to expand somewhat the period 0 bonus improvement factor. The total bonus improvement factor for the six-period interval from period −2 to period 3 gives a more accurate reflection of the increase in reenlistments brought about by the bonus. The reenlistment improvement factor is defined here as the bonus-induced change in the proportion of individuals surviving from period −2 to the end of period 3. This definition is based on the assumption that individuals still in the service 18 to 24 months after their ETS have indeed chosen to reenlist, and that those who extended without reenlisting have left by this time.

Table 4 presents the augmented bonus improvement factors (reenlistment improvement factors). For the unadjusted estimates, they are all larger than the period 0 bonus improvement factors alone. For the eligibility adjusted estimates, this is not always the case, mainly because the reduced attrition in the year prior to the ETS is not fully taken into account.

Table 4

REENLISTMENT IMPROVEMENT FACTORS
(Arc estimates)

	Not Adjusted for Eligibility		Adjusted for Eligibility	
16R	.128	(.155)	.068	(.082)
GMG	.332	(.400)	.228	(.273)
0811	.082	(.045)	.082	(.045)
31S	.196	(.173)	.089	(.079)
93H	−.082	(−.138)	−.053	(−.089)
AC	.083	(.348)	.060	(.251)
7322	.138	(.540)	.099	(.387)
272×0	.001	(.003)	−.011	(−.039)
98C	.138	(.206)	.059	(.089)
CTI	.010	(.020)	−.090	(−.183)
202×0	.009	(.006)	.002	(.001)
33S	.103	(.200)	n.a.	n.a.
AX	.113	(.204)	.063	(.113)
CTM	.044	(.165)	.044	(.163)
AF-COMB	.063	(.057)	.039	(.036)

NOTE: Elasticities evaluated at average SRB steps are in parentheses.

The estimates in Table 4 are also somewhat higher than those commonly reported from cross-sectional studies. Warner and Goldberg [1984], for example, report bonus improvement factors for reenlistment rates ranging from 0.018 to 0.055 for Navy enlisted personnel. The estimates by Rodney et al. [1980], also for the Navy, range from 0.07 to 0.21. But, as was pointed out in the Introduction, it is probable that estimates based on cross-sections contain a negative simultaneity bias, which is likely to be smaller in the survivor function model on which the improvement factors in Table 4 are based.

MAN-YEAR EFFECTS

Table 5 lists the relative (M) and absolute (M^+) improvement in man-years brought about by a one-step increase in the SRB over the sample average based on arc estimates. With the exception of the specialties where the survivor function is truncated because of unavailability of data, the time horizon for these man-year effects is the six-year interval from period -2 to period 9.[2] The skills are listed in declining order of magnitude of the relative man-year improvement (unadjusted for eligibility); the augmented bonus improvement factor that measures reenlistments (see Table 4) is included for comparison. It is seen that the ranking would not have been drastically different had it been based on Table 4.

Considering the not adjusted for eligibility estimates, and leaving aside PMOS 93H, it can be seen that a one step-increase in the first-term SRB would have brought about an increase in expected man-years ranging from 0.463 (PMOS 31S) to 0.002 (Rating CTI). The median seems to be between 0.1 and 0.2, with the Army showing somewhat larger increases.[3] Similar variation is reflected in the man-year improvement factors relative to the expected man-years during this interval. They range from .1 to 19 percent, with a median in the 6 percent range.

Compared with the augmented bonus improvement factors from Table 4, which measure the effect of SRBs on reenlistments rather than expected man-years, the bonus improvement factors for the proportional increases in man-years are smaller. In other words, multiplying the augmented bonus improvement factors from Table 4 with expected man-years would overestimate the net increase in man-years served, typically by a factor of about 1.5 to 2.

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[2]See Appendix B for details on the individual survivor functions and their time horizons.

[3]Such generalizations must be confined to the 15 specialties analyzed. Considering additional specialties might change those results.

Table 5

MAN-YEAR EFFECTS OF A ONE-STEP INCREASE IN THE SRB
(Arc estimates)

	Not Adjusted for Eligibility			Adjusted for Eligibility		
	Man-Years		Reenlistment	Man-Years		Reenlistment
Skill	Absolute	Relative	Relative[a]	Absolute	Relative	Relative[a]
GMG	.439	.194	.332	.372	.137	.228
31S	.463	.140	.196	.279	.068	.089
16R	.263	.088	.128	.199	.050	.068
98C	.215	.082	.138	.130	.038	.059
AX	.168	.066	.113	.105	.037	.063
AC	.157	.058	.083	.125	.041	.060
33S	.150	.057	.103	n.a.	n.a.	n.a.
7322	.161	.053	.138	.207	.057	.099
0811	.099	.047	.082	.099	.047	.082
AF-COMB	.069	.025	.063	.069	.019	.039
202×0	.040	.020	.009	.018	.007	.002
CTM	.037	.011	.044	.058	.017	.044
272×0	.006	.002	.001	−.021	−.007	−.011
CTI	.002	.001	.010	−.181	−.059	−.090
93H	−.244	−.069	−.082	−.181	−.045	−.053

[a]See Table 4.

Care has to be taken in comparing these different man-year estimates. For some specialties, bonus effects could only be estimated for a limited number of periods. The periods most often missing are those toward the end of the second term. In these cases, the higher attrition and lower reenlistment rates which servicemembers who were induced by bonuses to reenlist tend to display toward the end of the second term are not of course reflected. As a consequence, the relative man-year improvement factors for these specialties tend to be overestimated. The absolute man-year improvement factors are underestimates because they only add up the additional man-years over the periods for which estimates are available.

But even the specialties for which bonus effects in all 12 periods could be estimated may provide man-year improvement factors that are incomplete. In most instances, the proportion of individuals surviving in the service past the end of the observation interval (period 9) is still higher at the higher bonus step, despite the increased attrition in periods 8 and 9. It follows that the absolute increase in man-years due to a one-step increase over the entire career profile is probably larger than that indicated in Table 5 for most specialties. Nevertheless, the relative increase in man-years over the entire career is probably smaller than either the relative man-year improvement factor or the bonus improvement factor specific to period 0. For a discussion of how the different man-year measures relate to each other over the complete career profile, refer back to the end of Section II.

V. CONCLUSIONS

MAJOR FINDINGS

This report has presented a methodology for estimating specialty-specific bonus improvement factors. That this methodology is feasible has been demonstrated by successfully applying it to 15 military specialties. More important than the specific estimates obtained is the realization that it is possible to estimate such specialty-specific bonus improvement factors, for at least some specialties.

There was no reason to expect such large unexplained differences among bonus effects in different specialties as were found in this study. Even though the results must be interpreted with caution, primarily due to the potential specification errors arising from the incomplete treatment of demographic variables, the variation among specialties is very large. Not only do reenlistment rates vary greatly from specialty to specialty, but the response to bonuses also varies. Ignoring PMOS 93H (Army air controllers) for the reasons explained in the text, the bonus improvement effect on *reenlistments* varies from 0.001 to 0.332 (Table 4). Similarly, the proportional increase in man-years served over the 6-year interval considered here varies from a low of 0.001 (Navy rating CTI) to 0.194 (Navy rating GMG; see Table 5). Ignoring such differences and applying a uniform bonus improvement factor for all specialties will lead to substantial errors in predicting bonus effects for particular specialties. This concern is justified even though the differences found in this study must be interpreted with care. A more thorough specification of other explanatory variables, particularly demographic variables, might alter the specialty-specific results somewhat.

The survivor function approach described here has proven particularly useful for substantiating hypotheses on lead and lag effects of bonuses. It has been shown that there are lead effects in that individuals in expectation of a bonus are more likely to reach the first ETS than are individuals who have no reason to expect a bonus.[1] This finding is relevant because it implies that studies that estimate bonus

[1]This effect is curtailed if servicemembers who are not eligible for reenlistment are excluded, primarily because people leaving before their ETS are treated as ineligible to reenlist (ISC-02 to ISC-09). This group includes, among others, individuals who leave the service early to attend school (ISC-03) or to teach (ISC-07). Had they decided to stay until their ETS, many of the early leavers would probably have been eligible to reenlist.

improvement factors based on the population that reaches the first ETS tend to underestimate the effectiveness of the bonus.

It was also shown that people receiving bonuses at their first ETS are less likely to reenlist once they reach the second ETS. This finding has consequences for the way in which manpower planning models are used in the services. When predicting the effects of a first ETS bonus increase on the career force, the continuation rates for the second ETS have to be lowered. Without such an adjustment, the models will overestimate the number of people reaching nine or more years of service.

EVALUATING THE SURVIVOR FUNCTION APPROACH

It was the declared purpose of this project to test the usefulness of the survivor function approach to estimating bonus improvement factor. The model presented here is thus a prototype, and amenable to numerous modifications and improvements. Nevertheless, preliminary conclusions as to its usefulness as an instrument in implementing bonus policy can be drawn.

Many models based on longitudinal data are capable of estimating specialty-specific bonus improvement factors. It is also possible to estimate survivor functions from a cross-section, provided that it includes a sufficient diversity of cohorts. The novel aspect of the model presented here is that it combines the strengths of these approaches in a coherent model that can actually be estimated, albeit with some difficulty.

The coefficients that can be estimated in a survivor function model of the type presented here allow not only estimation of bonus improvement factors at the reenlistment point, but also evaluation of the bonuses' impact on continuation rates in other periods. In this respect it is clearly superior to the commonly used techniques because it provides all the information these techniques do plus some very relevant additional facts as well. Among the strongest points of this approach is that the effects of variables whose influence is not exclusively confined to the ETS period, such as expectations regarding bonus changes, changes in cohort composition as a result of bonuses, modifications to service directives regarding extensions, and so forth, can eventually be quantified and allocated to the respective periods. The net result is a reliable measure of the additional man-years generated, the only measure that is ultimately relevant in the evaluation of bonus benefits.

Man-year effects can be estimated from traditional bonus improvement factor estimates only if assumptions regarding the influence of a bonus on retention outside of the ETS period are made. Given that these models provide little basis for making the necessary assumptions, it is commonly assumed that bonus effects for periods other than the ETS period are zero. That this is wrong has been demonstrated even with the stripped-down prototype of a survivor function model presented here.

It is misleading to base bonus policy and allocations exclusively on the partial estimates provided by traditional methods, rather than considering the entire picture. A bonus-induced improvement in retention or reenlistments at the reenlistment point by x percent does not lead to an x percent increase in man-years served. The extent of the error committed appears furthermore to vary from specialty to specialty and from service to service. It is important that such differences be investigated and the effects of bonuses on the entire retention profile be considered.

The survivor function model described here offers the opportunity for doing this. However, this project has shown that the model development may be somewhat ahead of the currently available data. As long as only historical data from a few specialties with sufficient variation are available, the applicability of this approach will remain limited. But this is a problem of the data, not of the model,[2] and serious consideration should be given to a bonus experiment that would (at least partially) offset this shortcoming.

But even with fairly good data, estimating the kinds of models discussed here will not be inexpensive. The available algorithms for maximizing nonlinear likelihood functions tend to place heavy demands on computing resources. The problems are made worse by the unavoidably high colinearity typical of historical data. One consequence of colinearity is a very flat likelihood surface, which increases the number of iterations required for convergence of the parameter estimates. It also makes identification difficult, a problem that can often be resolved only through restrictive *a priori* assumptions.

The survivor function model is fortunately flexible enough to accept any number of *a priori* assumptions.[3] On the basis of the preliminary results obtained in this study, it is already possible to suggest some restrictions that might impose somewhat more structure on the model, and at the same time offer opportunities for improving the specification of the explanatory variables, especially the demographics. Some of these are discussed in the next subsection.

[2]Other models have not solved this shortcoming, they simply ignore it.

[3]With sufficient restrictive assumptions, this model can be reduced to a standard logit model of reenlistment choices capable of producing the usual SRB improvement factors.

FURTHER RESEARCH

In several places throughout the text it has been noted that future versions of this type of model could be modified depending on the specific policy questions raised. Besides the obvious broadening of the scope to include more specialties, the following modifications should be considered.

Additional Explanatory Variables

As far as the degrees of freedom allow, additional explanatory variables such as education, race, sex, and marital status should be included. Similarly, policy variables, such as changes in qualification requirements and staffing levels (end-year strength) should be considered. To make investigation of such additional effects feasible, it might be necessary to treat the bonus variable in less detail than is done here. For example, periods could be combined, and specialties that show similar bonus effects could be pooled.

SRBs at Second and Third ETS

The model presented here does not take into account the effect of bonuses offered at the second and third ETS. It is reasonable to presume that these bonuses would exert similar lead and lag effects as SRBs offered at the first ETS. Including the bonus offered at the second ETS might help identify the lag effect of the bonus offered at the first ETS more accurately.

Longer Observation Interval

It is likely that individuals who entered the services under the selective service system have considerably different attrition and retention probabilities than individuals who joined after 1973. For that reason, cohorts who reached their first reenlistment point before 1976 were excluded from this analysis. This, however, leaves only 18 cohorts to be analyzed, and thus a maximum of nine years of service. Furthermore, the data tend to become very sparse in the later periods.

Nevertheless, it would be desirable to increase the observation window beyond 4.5 years after the first ETS. The modeling will be easier as more and more data become available. As an intermediate step, one might consider obtaining estimates for continuation rates from the second ETS to the present by analyzing cross-sectional data. An alternative might be to include earlier cohorts to estimate the later periods in the retention profile. If these earlier cohorts were restricted to individuals who had been retained past their first ETS, the influence of all-volunteer force recruits versus those entering under the selective service system could be minimized. This minimization technique is based on the assumption that retention in the later periods no longer depends on conditions prevailing at the time of enlistment.

Sources of Differences in Bonus Improvement Factors

One puzzling result of this analysis is the large differences in bonus response among specialties. On the basis of the 15 specialties analyzed in this study, there appear no obvious groupings. Very loosely, one could observe that three of the four most responsive specialties, according to Table 5, are from the Army, whereas three of the four least responsive ones (excluding 93H) are from the Air Force. In each case, however, the fourth one is from the Navy. Similarly, it could be noted that two of the three most responsive occupation groups are combat specialties (GMG and 16R), whereas the less responsive ones are primarily technical specialties (air traffic controllers and analysts).

Before such conclusions can be reached, however, more specialties need to be analyzed. In addition, one would need to consider the form of the bonus payment in somewhat more detail. For example, Hosek and Peterson [1985] found that bonus response was diminished during the time that bonuses were paid in installments. This period seems to coincide somewhat with the periods of high bonus steps for the technical specialties included in this study.

Appendix A

COEFFICIENT ESTIMATES

Table A.1

COEFFICIENT ESTIMATES: DISREGARDING ELIGIBILITY

PMOS	16R	GMG	0811	31S
Intercept				
Period −2	−2.42500(25.45)	−3.15880(26.79)	−3.09860(30.79)	−3.31040(16.82)
Period −1	−2.68560(27.10)	−2.69800(26.60)	−2.87480(32.66)	−4.06970(12.16)
Period 0	−0.24270(5.95)	0.32718(9.16)	−0.03902(1.64)	−0.31038(5.07)
Period 1	−2.41170(15.11)	−1.76990(14.47)	−1.47020(22.28)	−2.19830(9.55)
Period 2	−3.73250(15.51)	−2.74800(15.87)	−2.35710(20.74)	−2.71030(8.96)
Period 3	−3.75780(14.19)	−3.38060(13.10)	−2.85870(16.72)	−4.13140(7.38)
Period 4	−4.08310(13.23)	−3.80460(11.63)	−3.23680(14.18)	−4.60520(6.63)
Period 5	−3.32880(13.32)	−3.23440(10.43)	−2.39480(13.78)	−2.94190(8.95)
Period 6	−3.76800(11.34)	−3.23710(8.84)	−2.47980(12.18)	−3.16420(8.29)
Period 7	−2.89710(10.26)	−2.87860(6.43)	−2.59510(9.63)	−2.86650(8.00)
Period 8	−3.58460(7.54)	−2.25250(4.79)	−2.54880(7.98)	−2.85090(7.05)
Period 9	−4.69860(7.29)	−4.08760(3.54)	−2.95960(7.16)	−3.19420(5.95)
Bonus step				
Period −2	−1.00930(8.51)	−0.63092(5.47)	0.02504(0.28)	−1.20520(2.57)
Period −1	−0.39209(4.51)	−0.50969(5.02)	−0.39674(4.02)	−0.69393(2.89)
Period 0	−0.14682(3.81)	−0.24766(8.30)	−0.01961(0.64)	−0.21835(3.00)
Period 1	−0.15557(1.29)	−0.20845(2.63)	−0.10225(1.12)	−1.10750(1.79)
Period 2	0.00869(0.06)	−0.24522(2.16)	−0.19323(1.10)	−1.10180(1.33)
Period 3	0.27230(1.75)	−0.06079(0.04)	−0.22380(0.93)	−0.18336(0.33)
Period 4	0.15349(0.85)	0.04752(0.30)	0.08280(0.35)	0.00000(assum)
Period 5	0.18987(1.29)	−0.03344(0.23)	−0.25163(1.19)	−0.29817(0.79)
Period 6	0.10584(0.53)	−0.12811(0.76)	−0.05332(0.27)	0.02237(0.08)
Period 7	−0.05110(0.29)	0.02391(0.13)	−0.04099(0.18)	−0.44543(1.04)
Period 8	0.28920(1.53)	−0.02369(0.13)	−0.28186(1.02)	0.15412(0.67)
Period 9	0.75665(3.51)	0.42442(1.02)	0.12448(0.42)	0.12036(0.44)
Unemployment				
Before ETS	−0.18800(9.61)	−0.66776(7.04)	−0.20752(3.40)	−0.65420(3.68)
After ETS	0.13893(2.58)	−0.35081(9.18)	0.07553(1.83)	0.03536(0.42)
At ETS	−0.02712(1.11)	−0.01511(0.64)	−0.02432(1.04)	−0.14841(2.57)
Pay ratio				
Before ETS	0.06573(9.84)	0.04048(1.80)	0.15016(8.74)	0.09061(1.66)
After ETS	−0.02196(0.92)	−0.02926(1.34)	0.04200(2.41)	−0.02293(0.58)
At ETS	−0.08368(7.55)	−0.01798(1.73)	−0.02010(2.06)	0.01475(0.66)
AFQT percentile				
Before ETS	0.00186(2.75)	0.01002(4.70)	−0.00126(0.76)	0.00388(0.80)
After ETS	0.00138(0.54)	−0.00028(0.14)	−0.00179(0.90)	0.01013(2.13)
At ETS	−0.00044(0.40)	0.00228(2.36)	−0.00061(0.63)	0.00785(3.20)
Avg. SRB step	1.20844	1.20174	0.55181	0.88584

Table A.1—continued

PMOS	93H	AC	7322	272×0
Intercept				
Period −2	−4.55190(9.40)	−4.94100(14.36)	−2.83580(2.14)	−3.47510(6.11)
Period −1	−5.49160(7.01)	−2.81800(11.15)	−4.98210(5.29)	−4.17750(7.56)
Period 0	−1.22710(12.17)	0.23588(1.51)	0.42690(1.31)	−0.07221(0.25)
Period 1	−2.49590(9.02)	−2.54390(7.20)	−3.23580(3.30)	−2.35020(3.44)
Period 2	−3.97300(6.65)	−3.14380(6.08)	−1.83670(1.03)	−2.64820(3.07)
Period 3	−4.18460(4.80)	−3.16590(4.80)	−2.54620(1.36)	−3.80200(3.82)
Period 4	−5.28510(6.59)	−2.79620(4.48)	−4.19780(4.22)	−2.65340(2.47)
Period 5	−2.84310(5.97)	−1.43890(1.68)	−3.17780(2.38)	−2.12730(2.37)
Period 6	−4.67140(5.50)	−2.70890(3.57)	−1.25470(0.52)	−1.18150(1.19)
Period 7	−3.04570(4.72)	−0.63055(0.69)	−3.14440(4.36)	−2.04960(2.51)
Period 8	−4.82580(3.80)	−2.64840(4.26)	n.a.	−3.30620(2.61)
Period 9	n.a.	n.a.	n.a.	n.a.
Bonus step				
Period −2	0.19905(0.85)	0.23228(3.13)	−0.56614(1.66)	−0.01259(0.08)
Period −1	0.50681(1.64)	−0.12138(1.89)	0.23426(1.44)	0.38456(2.64)
Period 0	0.17924(3.95)	−0.14507(3.64)	−0.26787(2.94)	−0.06532(0.82)
Period 1	−0.00874(0.06)	0.08040(0.88)	0.12924(0.50)	0.05213(0.26)
Period 2	0.04045(0.14)	0.08574(0.62)	−0.56914(0.96)	−0.04076(0.16)
Period 3	−0.21273(0.46)	−0.07184(0.37)	−0.30347(0.46)	0.24050(0.80)
Period 4	0.47934(1.54)	−0.11360(0.58)	0.38648(1.65)	−0.33524(0.90)
Period 5	−0.39770(2.01)	−0.72161(2.13)	0.10487(0.25)	−0.24332(0.76)
Period 6	0.45679(1.41)	−0.30954(1.15)	−0.47791(0.52)	−0.49872(1.33)
Period 7	0.12397(0.48)	−0.97017(2.37)	0.00000(assum)	−0.04652(0.17)
Period 8	0.95602(2.11)	0.08015(0.35)	n.a.	0.40173(0.85)
Period 9	n.a.	n.a.	n.a.	n.a.
Unemployment				
Before ETS	−0.33146(1.54)	−0.54043(2.94)	0.01108(0.03)	−0.12099(0.84)
After ETS	0.19240(1.27)	−0.05381(0.36)	−0.37625(0.96)	−0.02168(0.13)
At ETS	0.16687(2.20)	−0.14215(2.87)	−0.05333(0.30)	−0.08323(1.24)
Pay ratio				
Before ETS	−0.12479(1.46)	−0.04991(1.59)	0.11874(1.08)	−0.11495(4.53)
After ETS	0.10248(1.86)	−0.06521(1.53)	0.04457(0.42)	−0.01754(0.27)
At ETS	−0.06634(2.20)	−0.01903(1.08)	−0.00682(0.13)	−0.03053(1.60)
AFQT percentile				
Before ETS	0.02455(3.49)	−0.00317(1.22)	0.00470(0.33)	−0.00294(0.97)
After ETS	0.01930(4.09)	0.00223(0.75)	0.04135(2.59)	0.00570(1.27)
At ETS	0.01716(6.29)	0.00531(3.98)	0.01088(2.02)	0.00707(3.78)
Avg. SRB step	1.68419	4.20339	3.90772	3.6436

Table A.1—continued

PMOS	98C	CTI	202×0	33S
Intercept				
Period −2	−3.98880(24.84)	−6.38660(8.89)	−3.35990(23.82)	−7.51400(5.22)
Period −1	−4.20720(19.58)	−2.96830(6.25)	−2.47650(19.80)	−5.28710(8.43)
Period 0	−0.20771(4.39)	−0.43436(2.55)	−0.38637(5.40)	−0.01251(0.19)
Period 1	−1.70560(14.10)	−1.46100(3.30)	−2.81740(12.87)	−2.01170(11.85)
Period 2	−2.29330(13.17)	−1.81970(3.21)	−2.47360(12.69)	−2.92780(10.81)
Period 3	−3.15710(11.59)	−14.02700(32.68)	−3.28630(11.52)	−3.75610(8.88)
Period 4	−3.55160(10.57)	−2.94010(3.45)	−3.21780(10.61)	−4.43300(8.47)
Period 5	−3.16210(10.35)	−3.62010(5.60)	n.a.	−4.15140(7.83)
Period 6	−2.67600(11.27)	−1.92440(3.21)	n.a.	−2.65550(9.34)
Period 7	−2.60070(11.70)	−2.71250(3.14)	n.a.	−2.65040(8.18)
Period 8	n.a.	−3.07860(2.43)	n.a.	−1.81150(7.45)
Period 9	n.a.	−4.33520(3.16)	n.a.	n.a.
Bonus step				
Period −2	0.12592(2.06)	0.56985(1.96)	−0.17807(1.11)	0.76507(2.08)
Period −1	0.19479(2.36)	−0.18681(0.99)	−0.01101(0.11)	0.29149(1.44)
Period 0	−0.12865(4.53)	0.06088(0.75)	−0.10355(1.26)	−0.11060(3.55)
Period 1	−0.36361(4.39)	−0.37321(1.63)	0.42309(2.38)	−0.08406(1.05)
Period 2	−0.29272(2.81)	−0.20751(0.73)	−0.50021(1.34)	−0.35195(2.14)
Period 3	−0.28671(1.79)	0.00000(assum)	0.55542(1.80)	−0.33259(1.18)
Period 4	−0.35847(1.51)	−0.24666(0.61)	0.14507(0.31)	0.19555(0.92)
Period 5	−0.93227(2.49)	0.19879(0.83)	n.a.	−0.12180(0.35)
Period 6	−0.98050(2.73)	−0.41773(1.27)	n.a.	0.10364(0.59)
Period 7	−0.27151(1.20)	−0.68080(1.41)	n.a.	0.12378(0.60)
Period 8	n.a.	0.24612(0.50)	n.a.	−0.19028(0.65)
Period 9	n.a.	0.71212(1.52)	n.a.	n.a.
Unemployment				
Before ETS	−0.06925(0.41)	−0.86961(3.43)	−0.10704(0.95)	−0.59674(1.54)
After ETS	0.10358(1.46)	0.21478(3.83)	−0.09703(0.75)	−0.07849(0.71)
At ETS	−0.03756(0.78)	−0.10810(1.84)	0.27047(3.05)	0.16507(2.52)
Pay ratio				
Before ETS	−0.09852(1.82)	0.20565(2.23)	−0.12986(3.53)	−0.11244(1.21)
After ETS	0.01604(0.62)	0.18281(6.86)	−0.00781(0.21)	−0.07370(1.93)
At ETS	−0.01685(0.99)	0.01713(0.73)	−0.11596(4.24)	−0.06641(3.37)
AFQT percentile				
Before ETS	−0.00630(1.30)	−0.01335(2.85)	−0.00120(0.20)	0.01567(1.54)
After ETS	0.01039(2.62)	0.00205(0.77)	0.00889(1.29)	0.00206(0.38)
At ETS	0.00443(2.16)	0.00347(1.47)	0.00135(0.44)	0.00324(1.35)
Avg. SRB step	1.49773	2.0363	0.68737	1.93427

Table A.1—continued

PMOS	AX	CTM	AF-COMB
Intercept			
Period −2	−3.68860(11.83)	−8.21940(4.53)	−3.26930(24.82)
Period −1	−3.44370(13.33)	−3.50060(4.00)	−2.68240(25.09)
Period 0	−0.02592(0.38)	−0.17006(0.41)	−0.42722(10.00)
Period 1	−2.10250(9.87)	−3.39970(3.53)	−2.01820(16.46)
Period 2	−2.36300(9.63)	−4.34860(3.25)	−2.26110(15.15)
Period 3	−2.75560(7.66)	−1.30790(1.39)	−2.96520(12.71)
Period 4	−1.73740(6.20)	−2.36360(2.27)	−2.83850(11.10)
Period 5	−3.20050(5.41)	−4.55650(2.09)	−3.60110(8.96)
Period 6	−4.23090(4.77)	−6.82820(4.87)	−2.71010(9.77)
Period 7	−3.14440(5.17)	−4.45460(1.87)	−3.18540(9.54)
Period 8	−3.83860(3.91)	−3.56850(3.02)	−2.76500(8.95)
Period 9	−3.06080(3.52)	n.a.	−3.00940(7.87)
Bonus step			
Period −2	−0.31064(1.94)	0.98158(2.12)	−0.09202(1.10)
Period −1	−0.02332(0.19)	0.01206(0.05)	−0.07289(1.03)
Period 0	−0.08173(2.29)	−0.15999(1.46)	−0.00733(0.26)
Period 1	−0.18668(1.86)	0.12846(0.50)	−0.16396(2.09)
Period 2	−0.19791(1.61)	0.28150(0.80)	−0.30021(2.65)
Period 3	−0.56028(2.27)	−0.63240(2.23)	−0.34663(2.05)
Period 4	−0.25557(1.86)	−0.08741(0.30)	−0.20191(1.24)
Period 5	0.07044(0.33)	0.07786(0.13)	0.21147(1.13)
Period 6	0.48229(1.79)	0.96455(2.74)	0.24749(2.03)
Period 7	−0.03002(0.17)	0.22942(0.34)	0.35036(2.50)
Period 8	0.44896(1.59)	0.27195(0.81)	0.15329(1.03)
Period 9	0.12056(0.48)	n.a.	0.11736(0.68)
Unemployment			
Before ETS	−0.55139(3.18)	−0.28727(1.86)	0.16871(2.59)
After ETS	0.09955(1.43)	0.13376(1.87)	0.05758(1.37)
At ETS	−0.04176(1.02)	0.00769(0.13)	0.09867(2.90)
Pay ratio			
Before ETS	−0.10432(2.08)	0.07490(1.81)	−0.13976(8.29)
After ETS	0.02145(0.55)	0.03833(0.79)	−0.03780(1.73)
At ETS	−0.01431(0.71)	0.01060(0.45)	−0.08420(7.12)
AFQT percentile			
Before ETS	0.00196(0.50)	0.00323(0.38)	0.00202(1.05)
After ETS	0.00474(1.15)	−0.00308(0.54)	0.00277(1.00)
At ETS	0.00231(1.34)	0.00571(1.79)	−0.00053(0.47)
Avg. SRB step	1.79947	3.73443	0.9110414

NOTE: Absolute t-ratios are in parentheses.

AF-COMB consists of Air Force PMOS 304×1, 328×1, 328×3, and 328×4.

Table A.2

COEFFICIENT ESTIMATES: CONTROLLING FOR ELIGIBILITY

PMOS	16R	GMG	0811	31S
Intercept				
Period −2	−7.29700(9.21)	−5.36850(17.77)	−3.09860(30.79)	−4.94040(8.86)
Period −1	−6.95150(0.91)	−3.64080(20.93)	−2.87480(32.66)	−6.99930(3.82)
Period 0	−0.63558(13.56)	0.14096(3.83)	−0.03902(1.64)	−0.82815(11.47)
Period 1	−3.09470(14.46)	−2.08630(14.92)	−1.47020(22.28)	−2.95770(9.09)
Period 2	−5.20760(12.42)	−3.19830(15.20)	−2.35710(20.74)	−3.15840(9.21)
Period 3	−5.12650(10.75)	−4.08670(11.61)	−2.85870(16.72)	−4.47700(6.94)
Period 4	−5.57610(7.94)	−4.77110(8.83)	−3.23680(14.18)	−5.81770(5.97)
Period 5	−3.80670(12.12)	−5.31640(6.99)	−2.39480(13.78)	−3.18170(8.63)
Period 6	−5.41900(8.40)	−3.87030(7.61)	−2.47980(12.18)	−3.29950(8.09)
Period 7	−3.77040(8.90)	−3.68170(5.80)	−2.59510(9.63)	−3.38020(7.45)
Period 8	−3.73960(9.13)	−2.60650(4.89)	−2.54880(7.98)	−3.75250(6.14)
Period 9	−7.57320(5.42)	−6.30610(3.02)	−2.95960(7.16)	−3.50170(5.48)
Bonus step				
Period −2	−0.23591(0.27)	−0.37974(1.48)	0.02504(0.28)	−12.14300(6.44)
Period −1	0.11239(0.29)	−0.36612(1.87)	−0.39674(4.02)	−0.62817(1.17)
Period 0	−0.16416(3.68)	−0.22107(7.16)	−0.01961(0.64)	−0.22075(2.63)
Period 1	−0.03042(0.21)	−0.18045(2.07)	−0.10225(1.12)	−1.06280(1.27)
Period 2	0.23092(1.07)	−0.33763(2.20)	−0.19323(1.10)	−12.63100(32.25)
Period 3	−0.18032(0.26)	0.01210(0.07)	−0.22380(0.93)	−0.03896(0.07)
Period 4	−0.32300(0.25)	0.17169(0.68)	0.08280(0.35)	−0.00000(assum)
Period 5	−0.03861(0.18)	0.48610(1.66)	−0.25163(1.19)	−0.20281(0.54)
Period 6	0.53020(1.87)	−0.00561(0.03)	−0.05332(0.27)	−0.09956(0.29)
Period 7	−0.02778(0.11)	0.21899(0.89)	−0.04099(0.18)	0.26042(0.62)
Period 8	−0.06195(0.54)	0.05018(0.25)	−0.28186(1.02)	0.37018(1.26)
Period 9	1.43420(3.67)	1.05940(1.45)	0.12448(0.42)	0.21367(0.72)
Unemployment				
Prior to ETS	−0.73242(2.33)	−0.37670(3.62)	−0.26996(5.61)	−1.28410(1.09)
After ETS	0.03655(0.49)	−0.11360(2.24)	0.04221(1.14)	0.09712(0.89)
At ETS	−0.05476(2.01)	0.08062(3.69)	−0.05515(2.58)	−0.04281(0.66)
Pay ratio				
Prior to ETS	0.20066(1.55)	0.21761(4.04)	0.33901(17.19)	0.60419(1.41)
After ETS	−0.01742(0.51)	−0.05021(2.49)	0.03155(2.40)	0.03322(0.85)
At ETS	−0.04023(3.26)	−0.00522(0.56)	0.00230(0.31)	0.05937(2.53)
AFQT percentile				
Prior to ETS	−0.00304(0.20)	0.01395(3.98)	0.00293(2.16)	0.02246(1.48)
After ETS	0.00246(0.73)	−0.00203(0.90)	−0.00264(1.47)	0.01313(2.42)
At ETS	0.00138(1.14)	0.00185(2.04)	−0.00085(0.92)	0.00388(1.41)
Avg. SRB step	1.20844	1.20174	0.55181	0.88584

Table A.2—continued

PMOS	93H	AC	7322	272×0
Intercept				
Period −2	−5.10620(6.33)	−7.66500(7.72)	−15.15600(25.12)	−5.27320(calc)
Period −1	−9.23790(4.25)	−3.95940(9.51)	−7.53270(5.71)	−0.71899(2.21)
Period 0	−1.44890(13.15)	−0.04569(0.28)	0.17825(0.48)	−2.55610(3.02)
Period 1	−2.71740(8.40)	−2.60340(6.74)	−3.54400(3.31)	−2.73350(2.51)
Period 2	−4.12220(6.16)	−3.03440(5.52)	−1.52300(0.63)	−4.89660(3.01)
Period 3	−14.99700(18.39)	−3.41360(4.30)	−2.53470(1.02)	−1.59510(1.13)
Period 4	−5.40860(4.29)	−3.88310(13.39)	−5.44060(4.07)	−3.07490(1.94)
Period 5	−3.43490(6.27)	−1.74730(1.49)	−3.43390(2.04)	−1.02910(0.73)
Period 6	−5.98270(5.03)	−2.99410(3.23)	−1.16130(0.48)	−3.58680(3.16)
Period 7	−3.02670(4.49)	−0.28254(0.17)	−3.11940(4.35)	−2.57240(1.78)
Period 8	−5.25860(3.60)	−2.61550(4.12)	n.a.	n.a.
Period 9	n.a.	n.a.	n.a.	n.a.
Bonus step				
Period −2	−0.14273(0.34)	0.39239(1.98)	−0.16211(1.66)	0.19322(0.41)
Period −1	1.28570(1.72)	−0.00497(0.05)	0.36843(1.29)	0.00000(calc)
Period 0	0.16463(3.33)	−0.10557(2.54)	−0.28289(2.72)	0.02136(0.24)
Period 1	−0.04094(0.23)	0.05007(0.50)	0.18660(0.67)	−0.02183(0.09)
Period 2	−0.01869(0.05)	−0.00196(0.01)	−0.80355(0.96)	−0.14186(0.44)
Period 3	0.00009(0.00)	−0.13356(0.56)	−0.44236(0.50)	0.25368(0.54)
Period 4	0.15447(0.27)	0.00000(assum)	0.46133(1.78)	−0.77283(1.50)
Period 5	−0.30723(1.45)	−0.78161(1.61)	0.08608(0.16)	−0.25863(0.48)
Period 6	0.75580(1.77)	−0.36604(1.06)	−0.53885(0.58)	−0.75436(1.41)
Period 7	0.01753(0.06)	−1.39090(1.81)	0.00000(assum)	0.33074(0.96)
Period 8	1.07300(2.08)	0.07041(0.30)	n.a.	0.08855(0.16)
Period 9	n.a.	n.a.	n.a.	n.a.
Unemployment				
Prior to ETS	−0.36541(0.83)	−0.24694(1.18)	0.28590(0.26)	0.38577(1.17)
After ETS	0.08740(0.62)	−0.20992(1.83)	−0.42601(1.40)	−0.04814(0.33)
At ETS	0.03327(0.46)	−0.22771(4.76)	−0.15984(0.93)	0.05436(0.82)
Pay ratio				
Prior to ETS	0.18043(1.36)	0.09120(2.21)	0.27110(2.63)	−0.02954(0.34)
After ETS	0.03762(1.54)	−0.00357(0.12)	0.14382(1.42)	−0.04814(0.33)
At ETS	−0.02881(1.78)	−0.02846(1.89)	−0.00106(0.02)	−0.05436(0.82)
AFQT percentile				
Prior to ETS	0.05094(3.75)	0.00515(0.93)	0.06914(2.99)	0.00744(0.53)
After ETS	0.00776(1.66)	0.00572(1.78)	0.01441(1.40)	0.00274(0.61)
At ETS	0.01502(5.10)	0.00411(3.24)	0.00626(1.34)	0.00611(3.25)
Avg. SRB step	1.68419	4.20339	3.90772	3.6436

Table A.2—continued

PMOS	98C	CTI	202×0
Intercept			
Period −2	−5.26700(17.60)	−17.46300(46.28)	−6.91200(12.82)
Period −1	−5.93780(13.07)	−3.12480(5.14)	−6.53790(18.47)
Period 0	−0.79308(14.16)	−0.73809(3.94)	−0.96831(11.42)
Period 1	−2.27800(14.88)	−1.87840(4.74)	−3.91700(10.34)
Period 2	−2.85520(13.13)	−2.49920(4.47)	−3.08150(11.80)
Period 3	−3.98700(10.76)	−20.00000(assum)	−4.17430(9.70)
Period 4	−4.59460(9.65)	−3.64250(2.65)	−4.02100(9.08)
Period 5	−4.37620(9.09)	−17.15500(82.25)	n.a.
Period 6	−3.81980(12.77)	−3.08870(3.59)	n.a.
Period 7	−3.73880(9.85)	−3.01720(3.01)	n.a.
Period 8	n.a.	−3.26620(2.83)	n.a.
Period 9	n.a.	−4.62920(3.69)	n.a.
Bonus step			
Period −2	0.08976(0.75)	0.08942(0.50)	0.68957(2.16)
Period −1	0.32112(2.31)	−0.32132(1.18)	−0.29530(0.71)
Period 0	−0.08137(2.49)	0.15199(1.72)	−0.10113(1.05)
Period 1	−0.32496(3.28)	−0.18330(0.94)	0.60000(2.32)
Period 2	−0.28627(2.18)	0.10471(0.39)	−0.30791(0.72)
Period 3	−0.11675(0.59)	0.00000(assum)	0.53612(1.24)
Period 4	−0.03027(0.12)	−0.33609(0.45)	0.32613(0.59)
Period 5	−0.30333(0.82)	0.05508(0.57)	n.a.
Period 6	0.00000(assum)	−0.16585(0.41)	n.a.
Period 7	−0.43624(0.89)	−6.48200(12.69)	n.a.
Period 8	n.a.	−0.02576(0.05)	n.a.
Period 9	n.a.	0.66286(1.58)	n.a.
Unemployment			
Prior to ETS	−0.49513(2.18)	−1.10630(4.80)	−1.43170(2.32)
After ETS	0.02601(0.34)	0.11876(2.26)	−0.06883(0.39)
At ETS	−0.03005(0.60)	−0.04852(0.86)	0.08406(0.93)
Pay ratio			
Prior to ETS	0.12483(1.51)	0.31653(3.87)	0.22328(1.21)
After ETS	−0.01277(0.56)	0.04644(2.57)	−0.03990(0.99)
At ETS	−0.00864(0.62)	−0.02442(1.24)	−0.04516(1.76)
AFQT percentile			
Prior to ETS	0.00278(0.26)	−0.01310(2.22)	0.03866(2.30)
After ETS	0.01239(2.29)	0.00024(0.09)	−0.00145(0.19)
At ETS	0.00193(0.90)	0.00415(1.71)	0.00235(0.77)
Avg. SRB step	1.49773	2.0363	0.68737

Table A.2—continued

PMOS	AX	CTM	AF-COMB
Intercept			
Period −2	−6.50730(8.40)	−18.05600(14.14)	−6.04830(12.19)
Period −1	−4.83010(11.55)	−5.19010(3.43)	−6.35080(10.32)
Period 0	−0.18971(2.69)	−0.39166(0.91)	−0.74320(15.51)
Period 1	−2.31150(10.19)	−3.10160(3.12)	−2.31470(16.21)
Period 2	−2.47680(9.65)	−4.21330(3.10)	−2.77710(14.97)
Period 3	−3.11700(7.07)	−0.96974(0.99)	−4.11110(11.43)
Period 4	−1.84530(6.23)	−2.13550(1.98)	−3.04110(11.08)
Period 5	−3.30680(10.25)	−4.53040(2.07)	−4.94940(6.15)
Period 6	−4.72980(4.86)	−6.79660(4.83)	−2.98930(9.09)
Period 7	−3.36580(3.93)	−4.42730(1.84)	−3.51510(9.69)
Period 8	−3.78130(3.98)	−3.34620(2.74)	−3.48030(8.55)
Period 9	−3.32340(3.32)	n.a.	−3.40150(7.80)
Bonus step			
Period −2	0.35796(1.24)	0.51842(1.63)	−0.17579(0.57)
Period −1	0.30521(1.71)	0.34200(0.88)	−0.35442(0.91)
Period 0	−0.04884(1.31)	−0.12166(1.06)	−0.02246(0.71)
Period 1	−0.22573(2.07)	0.00101(0.00)	−0.18621(2.02)
Period 2	−0.21557(1.66)	0.23297(0.65)	−0.31974(2.20)
Period 3	−0.62823(1.84)	−0.78459(2.57)	−0.04450(0.21)
Period 4	−0.31892(2.11)	−0.18893(0.62)	−0.43483(1.98)
Period 5	0.00000(assum)	0.07101(0.12)	0.09039(0.21)
Period 6	0.58635(2.05)	0.95743(2.71)	0.16719(1.06)
Period 7	−0.21223(0.77)	0.22399(0.33)	0.43135(2.92)
Period 8	0.43668(1.60)	0.17666(0.50)	0.35292(1.99)
Period 9	0.17945(0.63)	n.a.	0.20121(1.05)
Unemployment			
Prior to ETS	−0.32202(1.79)	−0.26356(1.24)	0.40097(2.05)
After ETS	0.05215(0.82)	0.06874(0.92)	0.09925(1.93)
At ETS	−0.05165(1.30)	−0.00393(0.06)	0.02745(0.97)
Pay ratio			
Prior to ETS	0.02021(0.21)	0.20262(2.62)	−0.17393(1.65)
After ETS	0.04782(1.74)	0.07203(1.76)	−0.04337(2.06)
At ETS	−0.02270(1.28)	0.00600(0.24)	−0.05075(5.38)
AFQT percentile			
Prior to ETS	0.02148(2.44)	0.01220(0.92)	0.01198(0.99)
After ETS	0.00462(1.23)	0.00281(0.48)	0.00303(1.06)
At ETS	0.00294(1.75)	0.00722(2.29)	−0.00041(0.34)
Avg. SRB step	1.79947	3.73443	0.9110414

NOTE: Absolute t-ratios are in parentheses.

Appendix B

SURVIVOR FUNCTIONS

Table B.1

CONTINUATION RATES AND SURVIVOR FUNCTIONS
(Unadjusted)

Occupation and Service	Period -2	-1	0	1	2	3	4	5	6	7	8	9
PMOS 16R (Army)												
Continuation rate												
at avg. bonus (1.21)	0.974	0.958	0.518	0.928	0.976	0.968	0.980	0.956	0.974	0.949	0.961	0.978
at avg. bonus +1	0.991	0.972	0.567	0.938	0.976	0.958	0.977	0.947	0.971	0.952	0.949	0.953
Survivor function												
at avg. bonus (1.21)	0.974	0.934	0.484	0.449	0.439	0.425	0.416	0.398	0.387	0.368	0.354	0.346
at avg. bonus +1	0.991	0.963	0.546	0.512	0.500	0.479	0.468	0.443	0.430	0.410	0.389	0.370
PMOS GMG (Navy)												
Continuation rate												
at avg. bonus (1.20)	0.980	0.964	0.357	0.876	0.953	0.969	0.977	0.963	0.967	0.944	0.903	0.972
at avg. bonus +1	0.990	0.978	0.448	0.898	0.963	0.971	0.976	0.964	0.971	0.942	0.905	0.958
Survivor function												
at avg. bonus (1.20)	0.980	0.945	0.337	0.296	0.282	0.273	0.267	0.257	0.248	0.234	0.212	0.206
at avg. bonus +1	0.989	0.968	0.433	0.389	0.375	0.364	0.355	0.342	0.332	0.313	0.283	0.271
PMOS 0811 (Marines)												
Continuation rate												
at avg. bonus (.552)	0.955	0.956	0.386	0.805	0.918	0.951	0.960	0.924	0.922	0.930	0.935	0.946
at avg. bonus +1	0.954	0.970	0.393	0.822	0.932	0.960	0.956	0.940	0.926	0.932	0.951	0.939
Survivor function												
at avg. bonus (.552)	0.955	0.913	0.353	0.284	0.261	0.248	0.238	0.220	0.202	0.188	0.176	0.167
at avg. bonus +1	0.954	0.926	0.364	0.299	0.279	0.268	0.256	0.241	0.223	0.208	0.198	0.186

Table B.1—continued

Occupation and Service	Period -2	-1	0	1	2	3	4	5	6	7	8	9
PMOS 31S (Army)												
Continuation rate												
at avg. bonus (0.89)	0.988	0.991	0.546	0.959	0.975	0.986	0.990	0.960	0.958	0.962	0.936	0.955
at avg. bonus +1	0.996	0.995	0.615	0.986	0.992	0.989	0.990	0.970	0.957	0.976	0.926	0.950
Survivor function												
at avg. bonus (0.89)	0.988	0.978	0.535	0.513	0.500	0.493	0.489	0.469	0.449	0.432	0.405	0.387
at avg. bonus +1	0.996	0.995	0.610	0.602	0.597	0.590	0.584	0.567	0.542	0.530	0.490	0.465
PMOS 93H (Army)												
Continuation rate												
at avg. bonus (1.68)	0.985	0.990	0.673	0.922	0.980	0.989	0.989	0.971	0.980	0.943	0.961	n.a.
at avg. bonus +1	0.982	0.984	0.622	0.923	0.979	0.991	0.982	0.980	0.969	0.936	0.901	n.a.
Survivor function												
at avg. bonus (1.68)	0.985	0.976	0.656	0.605	0.593	0.587	0.580	0.563	0.552	0.521	0.500	n.a.
at avg. bonus +1	0.982	0.967	0.602	0.555	0.543	0.539	0.529	0.519	0.502	0.470	0.423	n.a.
PMOS AC (Navy)												
Continuation rate												
at avg. bonus (4.20)	0.981	0.965	0.503	0.896	0.940	0.969	0.963	0.989	0.982	0.991	0.906	n.a.
at avg. bonus +1	0.976	0.969	0.551	0.887	0.935	0.971	0.967	0.994	0.987	0.997	0.898	n.a.
Survivor function												
at avg. bonus (4.20)	0.981	0.947	0.476	0.426	0.401	0.388	0.374	0.370	0.363	0.360	0.326	n.a.
at avg. bonus +1	0.976	0.946	0.522	0.463	0.433	0.420	0.406	0.404	0.399	0.397	0.357	n.a.

Table B.1—continued

Occupation and Service	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
PMOS 7322 (Marines)												
Continuation rate												
at avg. bonus (3.91)	0.994	0.983	0.584	0.937	0.983	0.976	0.934	0.939	0.957	0.958	n.a.	n.a.
at avg. bonus +1	0.996	0.979	0.663	0.928	0.990	0.982	0.905	0.933	0.973	0.958	n.a.	n.a.
Survivor function												
at avg. bonus (3.91)	0.994	0.977	0.570	0.534	0.525	0.513	0.479	0.450	0.430	0.412	n.a.	n.a.
at avg. bonus +1	0.996	0.975	0.646	0.600	0.594	0.584	0.528	0.492	0.479	0.459	n.a.	n.a.
PMOS 272×0 (Air Force)												
Continuation rate												
at avg. bonus (3.64)	0.971	0.940	0.480	0.891	0.941	0.948	0.979	0.952	0.951	0.897	0.853	n.a.
at avg. bonus +1	0.971	0.913	0.503	0.886	0.943	0.934	0.985	0.962	0.970	0.901	0.789	n.a.
Survivor function												
at avg. bonus (1.50)	0.971	0.912	0.438	0.390	0.367	0.348	0.341	0.325	0.309	0.277	0.236	n.a.
at avg. bonus +1	0.971	0.886	0.446	0.395	0.372	0.348	0.343	0.330	0.320	0.288	0.228	n.a.
PMOS 98C (Army)												
Continuation rate												
at avg. bonus (1.50)	0.978	0.980	0.512	0.900	0.937	0.973	0.983	0.990	0.984	0.952	n.a.	n.a.
at avg. bonus +1	0.975	0.976	0.555	0.929	0.953	0.979	0.988	0.996	0.994	0.963	n.a.	n.a.
Survivor function												
at avg. bonus (1.50)	0.978	0.959	0.490	0.441	0.414	0.402	0.396	0.391	0.385	0.367	n.a.	n.a.
at avg. bonus +1	0.975	0.952	0.528	0.491	0.467	0.458	0.452	0.451	0.448	0.431	n.a.	n.a.

Table B.1 continued

Occupation and Service	Period 2	1	0	1	2	3	4	5	6	7	8	9
PMOS CTI (Navy)												
Continuation rate												
at avg. bonus (2.04)	0.995	0.965	0.480	0.897	0.899	0.999	0.969	0.961	0.940	0.984	0.927	0.946
at avg. bonus + 1	0.991	0.971	0.459	0.928	0.917	0.999	0.975	0.952	0.960	0.992	0.907	0.892
Survivor function												
at avg. bonus (2.04)	0.995	0.960	0.461	0.414	0.372	0.372	0.360	0.346	0.325	0.320	0.297	0.280
at avg. bonus + 1	0.991	0.962	0.441	0.410	0.376	0.376	0.366	0.349	0.335	0.332	0.301	0.269
PMOS 202 + 0 (Air Force)												
Continuation rate												
at avg. bonus (0.69)	0.970	0.920	0.531	0.923	0.942	0.947	0.957	n.a.	n.a.	n.a.	n.a.	n.a.
at avg. bonus + 1	0.975	0.921	0.565	0.885	0.964	0.909	0.950	n.a.	n.a.	n.a.	n.a.	n.a.
Survivor function												
at avg. bonus (0.69)	0.970	0.892	0.474	0.437	0.412	0.390	0.373	n.a.	n.a.	n.a.	n.a.	n.a.
at avg. bonus + 1	0.975	0.921	0.565	0.885	0.964	0.909	0.950	n.a.	n.a.	n.a.	n.a.	n.a.
PMOS 33S (Army)												
Continuation rate												
at avg. bonus (1.93)	0.998	0.991	0.451	0.893	0.973	0.988	0.983	0.988	0.918	0.914	0.893	n.a.
at avg. bonus + 1	0.995	0.988	0.490	0.901	0.981	0.991	0.979	0.989	0.909	0.903	0.911	n.a.
Survivor function												
at avg. bonus (1.93)	0.998	0.989	0.445	0.398	0.387	0.382	0.376	0.371	0.340	0.311	0.278	n.a.
at avg. bonus + 1	0.995	0.983	0.481	0.434	0.425	0.422	0.413	0.408	0.371	0.335	0.306	n.a.

Table B.1—continued

Occupation and Service	Period											
	-2	-1	0	1	2	3	4	5	6	7	8	9
PMOS AX (Navy)												
Continuation rate												
at avg. bonus (1.80)	0.986	0.970	0.432	0.916	0.936	0.977	0.895	0.955	0.966	0.960	0.953	0.943
at avg. bonus +1	0.990	0.971	0.461	0.930	0.947	0.987	0.918	0.952	0.945	0.961	0.927	0.936
Survivor function												
at avg. bonus (1.80)	0.986	0.956	0.412	0.378	0.354	0.346	0.310	0.295	0.285	0.274	0.261	0.246
at avg. bonus +1	0.990	0.960	0.442	0.411	0.390	0.385	0.353	0.336	0.318	0.305	0.283	0.265
PMOS CTM (Navy)												
Continuation rate												
at avg. bonus (3.73)	0.990	0.969	0.629	0.947	0.964	0.975	0.934	0.986	0.961	0.973	0.925	n.a.
at avg. bonus +1	0.972	0.969	0.673	0.941	0.952	0.987	0.940	0.985	0.901	0.966	0.903	n.a.
Survivor function												
at avg. bonus (3.73)	0.990	0.959	0.603	0.571	0.550	0.537	0.501	0.494	0.475	0.462	0.428	n.a.
at avg. bonus +1	0.972	0.942	0.634	0.596	0.568	0.560	0.526	0.518	0.467	0.451	0.408	n.a.
PMOS AF-COMB (Air Force)												
Continuation rate												
at avg. bonus (0.91)	0.966	0.938	0.523	0.892	0.924	0.963	0.952	0.967	0.920	0.944	0.930	0.947
at avg. bonus +1	0.969	0.942	0.526	0.907	0.943	0.974	0.961	0.960	0.899	0.922	0.919	0.940
Survivor function												
at avg. bonus (0.91)	0.966	0.902	0.474	0.423	0.390	0.376	0.358	0.346	0.319	0.301	0.280	0.265
at avg. bonus +1	0.969	0.913	0.480	0.435	0.410	0.399	0.384	0.369	0.331	0.306	0.231	0.264

Table B.2

CONTINUATION RATES AND SURVIVOR FUNCTIONS
(Adjusted for eligibility)

Occupation and Service	Period											
	-2	-1	0	1	2	3	4	5	6	7	8	9
PMOS 16R (Army)												
Continuation rate												
at avg. bonus (1.21)	0.999	0.998	0.647	0.957	0.992	0.995	0.997	0.979	0.991	0.977	0.978	0.997
at avg. bonus + 1	0.999	0.998	0.691	0.958	0.990	0.996	0.998	0.979	0.985	0.978	0.979	0.987
Survivor function												
at avg. bonus (1.21)	0.999	0.998	0.646	0.619	0.614	0.611	0.610	0.597	0.592	0.579	0.566	0.564
at avg. bonus + 1	0.999	0.998	0.690	0.661	0.655	0.653	0.652	0.638	0.629	0.616	0.603	0.596
PMOS GMG (Navy)												
Continuation rate												
at avg. bonus (1.20)	0.997	0.983	0.413	0.904	0.973	0.983	0.989	0.991	0.979	0.967	0.924	0.993
at avg. bonus + 1	0.997	0.988	0.492	0.919	0.980	0.982	0.987	0.985	0.979	0.960	0.920	0.981
Survivor function												
at avg. bonus (1.20)	0.997	0.980	0.405	0.366	0.357	0.351	0.347	0.344	0.337	0.326	0.301	0.299
at avg. bonus + 1	0.997	0.986	0.486	0.447	0.438	0.431	0.425	0.419	0.411	0.394	0.363	0.356
PMOS 0811 (Marines)												
Continuation rate												
at avg. bonus (0.55)	0.955	0.955	0.386	0.804	0.918	0.950	0.959	0.923	0.921	0.929	0.935	0.945
at avg. bonus + 1	0.954	0.969	0.393	0.821	0.932	0.960	0.956	0.940	0.925	0.932	0.950	0.939
Survivor function												
at avg. bonus (0.55)	0.955	0.912	0.352	0.283	0.260	0.247	0.237	0.219	0.202	0.188	0.176	0.166
at avg. bonus + 1	0.954	0.925	0.364	0.299	0.278	0.267	0.256	0.240	0.222	0.207	0.197	0.185

Table B.2—continued

Occupation and Service	Period -2	-1	0	1	2	3	4	5	6	7	8	9
PMOS 31S (Army)												
Continuation rate												
at avg. bonus (0.89)	0.992	0.999	0.698	0.979	0.958	0.989	0.997	0.965	0.966	0.973	0.967	0.964
at avg. bonus +1	0.992	0.999	0.749	0.993	0.958	0.989	0.997	0.972	0.969	0.979	0.953	0.955
Survivor function												
at avg. bonus (0.89)	0.992	0.992	0.692	0.678	0.650	0.643	0.641	0.619	0.599	0.583	0.564	0.544
at avg. bonus +1	0.992	0.992	0.744	0.738	0.708	0.700	0.698	0.679	0.658	0.645	0.615	0.587
PMOS 93H (Army)												
Continuation rate												
at avg. bonus (1.68)	0.995	0.999	0.733	0.940	0.984	0.999	0.994	0.980	0.991	0.951	0.968	n.a.
at avg. bonus +1	0.995	0.996	0.693	0.942	0.984	0.999	0.993	0.985	0.981	0.950	0.911	n.a.
Survivor function												
at avg. bonus (1.68)	0.995	0.994	0.729	0.685	0.675	0.675	0.671	0.658	0.652	0.620	0.601	n.a.
at avg. bonus +1	0.995	0.992	0.689	0.649	0.639	0.639	0.635	0.626	0.614	0.583	0.532	n.a.
PMOS AC (Navy)												
Continuation rate												
at avg. bonus (4.20)	0.997	0.981	0.541	0.912	0.953	0.981	0.979	0.993	0.989	0.997	0.906	n.a.
at avg. bonus +1	0.996	0.981	0.576	0.908	0.953	0.983	0.979	0.997	0.992	0.999	0.899	n.a.
Survivor function												
at avg. bonus (4.20)	0.997	0.979	0.530	0.484	0.461	0.452	0.443	0.440	0.436	0.435	0.394	n.a.
at avg. bonus +1	0.996	0.978	0.563	0.511	0.488	0.480	0.470	0.468	0.465	0.465	0.418	n.a.

Table B.2—continued

Occupation and Service	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
PMOS 7322 (Marines)												
Continuation rate												
at avg. bonus (3.91)	0.999	0.997	0.673	0.941	0.990	0.986	0.974	0.955	0.962	0.956	n.a.	n.a.
at avg. bonus +1	0.999	0.996	0.742	0.930	0.995	0.990	0.959	0.951	0.978	0.956	n.a.	n.a.
Survivor function												
at avg. bonus (3.91)	0.999	0.997	0.671	0.632	0.626	0.617	0.601	0.575	0.553	0.529	n.a.	n.a.
at avg. bonus +1	0.999	0.996	0.739	0.688	0.685	0.679	0.651	0.620	0.606	0.580	n.a.	n.a.
PMOS 2720 (Air Force)												
Continuation rate												
at avg. bonus (3.64)	0.996	0.994	0.590	0.930	0.961	0.981	0.987	0.982	0.977	0.911	0.899	n.a.
at avg. bonus +1	0.996	0.994	0.583	0.932	0.966	0.976	0.994	0.986	0.989	0.879	0.891	n.a.
Survivor function												
at avg. bonus (3.64)	0.996	0.991	0.585	0.545	0.524	0.514	0.508	0.499	0.488	0.445	0.400	n.a.
at avg. bonus +1	0.996	0.991	0.578	0.539	0.521	0.509	0.506	0.499	0.494	0.434	0.387	n.a.
PMOS 98C (Army)												
Continuation rate												
at avg. bonus (1.50)	0.994	0.995	0.669	0.938	0.963	0.984	0.990	0.992	0.978	0.987	n.a.	n.a.
at avg. bonus +1	0.993	0.994	0.691	0.955	0.972	0.986	0.990	0.994	0.978	0.992	n.a.	n.a.
Survivor function												
at avg. bonus (1.50)	0.994	0.989	0.663	0.622	0.599	0.590	0.584	0.580	0.567	0.560	n.a.	n.a.
at avg. bonus +1	0.993	0.987	0.682	0.652	0.634	0.625	0.619	0.616	0.602	0.597	n.a.	n.a.

Table B.2—continued

Occupation and Service	Period											
	−2	−1	0	1	2	3	4	5	6	7	8	9
PMOS CTI (Navy)												
Continuation rate												
at avg. bonus (2.04)	0.999	0.977	0.521	0.900	0.903	0.999	0.986	0.999	0.968	0.999	0.964	0.963
at avg. bonus +1	0.999	0.983	0.468	0.916	0.893	0.999	0.990	0.999	0.972	0.999	0.965	0.929
Survivor function												
at avg. bonus (2.04)	0.999	0.977	0.509	0.458	0.414	0.414	0.408	0.408	0.395	0.395	0.381	0.367
at avg. bonus +1	0.999	0.983	0.460	0.422	0.377	0.377	0.373	0.373	0.363	0.363	0.350	0.326
PMOS 202×0 (Air Force)												
Continuation rate												
at avg. bonus (0.69)	0.998	0.998	0.701	0.970	0.963	0.978	0.977	n.a.	n.a.	n.a.	n.a.	
at avg. bonus +1	0.996	0.999	0.726	0.946	0.973	0.962	0.969	n.a.	n.a.	n.a.	n.a.	
Survivor function												
at avg. bonus (0.69)	0.998	0.997	0.699	0.679	0.654	0.639	0.625	n.a.	n.a.	n.a.	n.a.	
at avg. bonus +1	0.996	0.995	0.723	0.684	0.666	0.641	0.621	n.a.	n.a.	n.a.	n.a.	
PMOS 33S (Army)												
Continuation rate												
at avg. bonus (1.93)			Underidentified									
at avg. bonus +1			Underidentified									
Survivor function												
at avg. bonus (1.93)			Underidentified									
at avg. bonus +1			Underidentified									

Table B.2—continued

Occupation and Service	Period											
	-2	-1	0	1	2	3	4	5	6	7	8	9
PMOS AX (Navy)												
Continuation rate												
at avg. bonus (1.80)	0.997	0.986	0.468	0.936	0.944	0.985	0.914	0.964	0.974	0.976	0.951	0.951
at avg. bonus +1	0.995	0.981	0.486	0.948	0.955	0.992	0.937	0.964	0.955	0.981	0.925	0.942
Survivor function												
at avg. bonus (1.80)	0.997	0.983	0.461	0.431	0.407	0.401	0.367	0.354	0.345	0.337	0.321	0.305
at avg. bonus +1	0.995	0.977	0.475	0.450	0.430	0.427	0.400	0.386	0.368	0.361	0.334	0.315
PMOS CTM (Navy)												
Continuation rate												
at avg. bonus (3.73)	0.999	0.980	0.651	0.955	0.965	0.979	0.943	0.986	0.960	0.972	0.934	n.a.
at avg. bonus +1	0.999	0.972	0.683	0.955	0.956	0.990	0.952	0.985	0.901	0.966	0.921	n.a.
Survivor function												
at avg. bonus (3.73)	0.999	0.980	0.638	0.610	0.588	0.577	0.544	0.536	0.515	0.501	0.468	n.a.
at avg. bonus +1	0.999	0.972	0.664	0.635	0.607	0.602	0.573	0.565	0.509	0.492	0.453	n.a.
PMOS AF-COMB (Air Force)												
Continuation rate												
at avg. bonus (0.91)	0.997	0.998	0.627	0.920	0.954	0.984	0.968	0.992	0.943	0.956	0.958	0.960
at avg. bonus +1	0.998	0.999	0.634	0.933	0.966	0.985	0.979	0.991	0.933	0.934	0.941	0.952
Survivor function												
at avg. bonus (0.91)	0.997	0.996	0.625	0.575	0.549	0.540	0.523	0.519	0.490	0.468	0.449	0.431
at avg. bonus +1	0.998	0.997	0.632	0.590	0.570	0.562	0.550	0.545	0.509	0.475	0.447	0.426

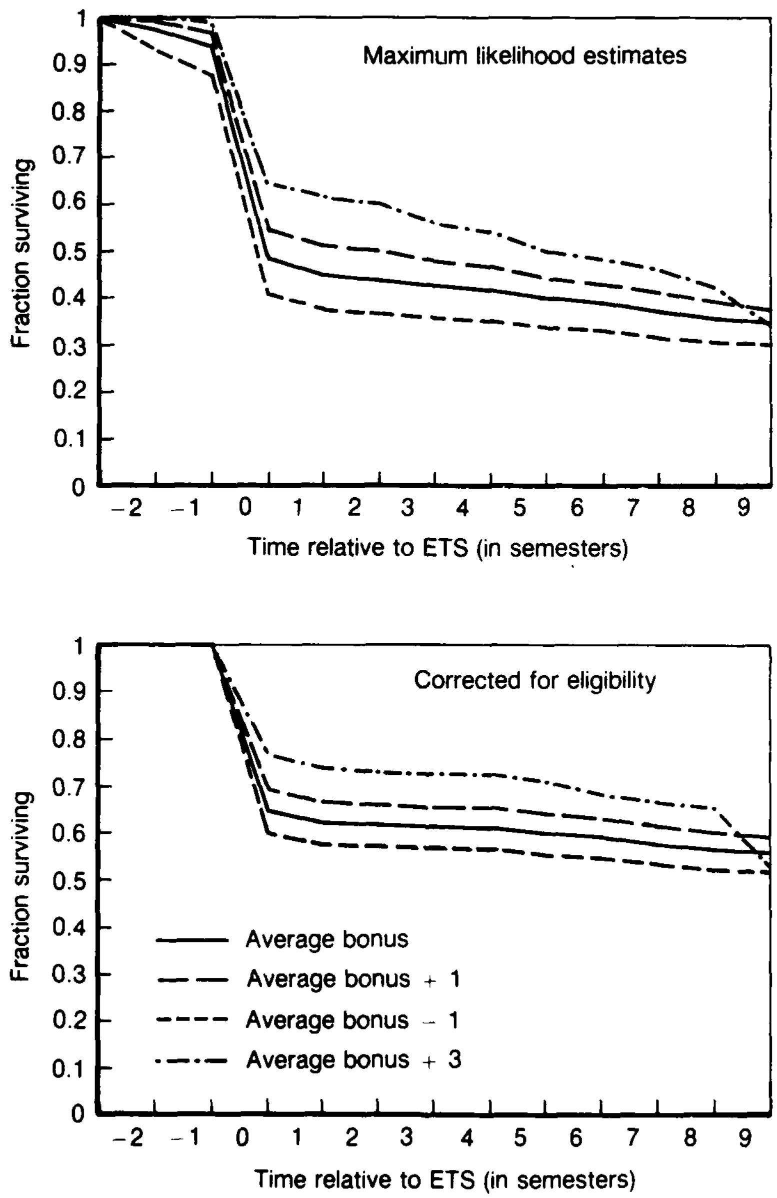


Fig. B.1—Survivor function PMOS 16R

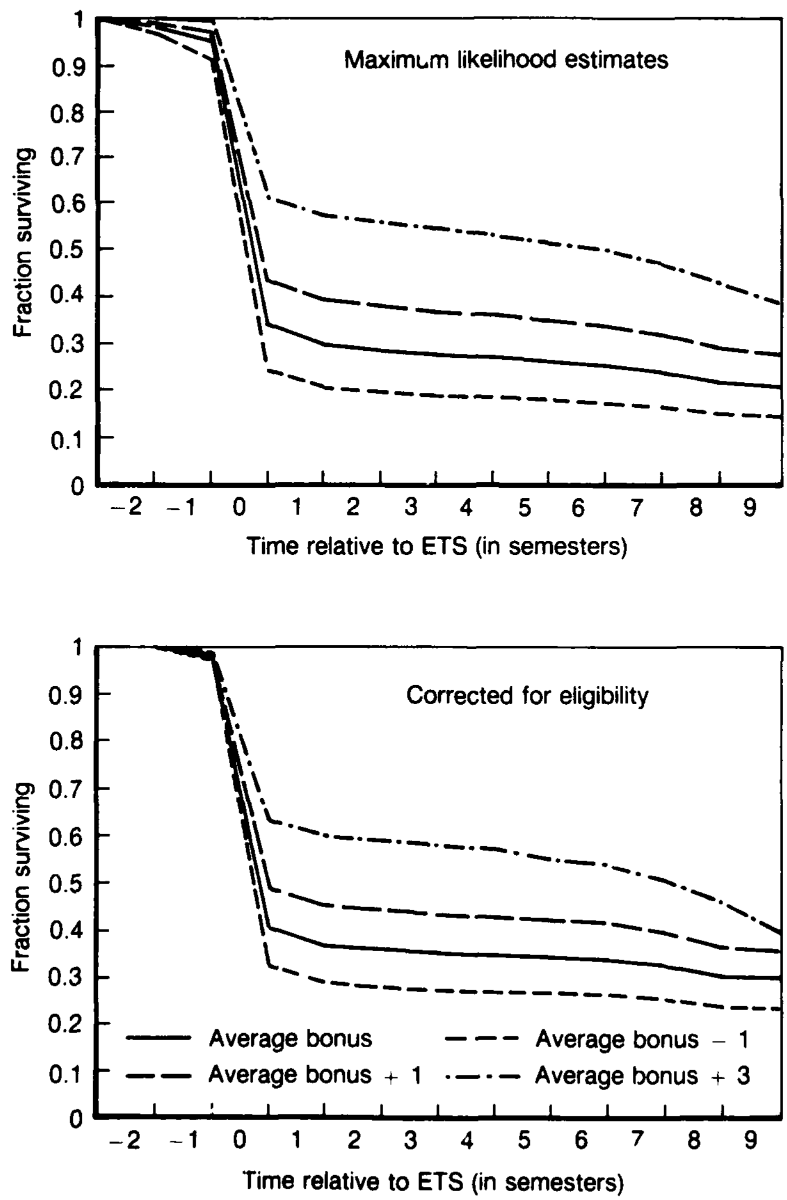


Fig. B.2—Survivor function PMOS GMG

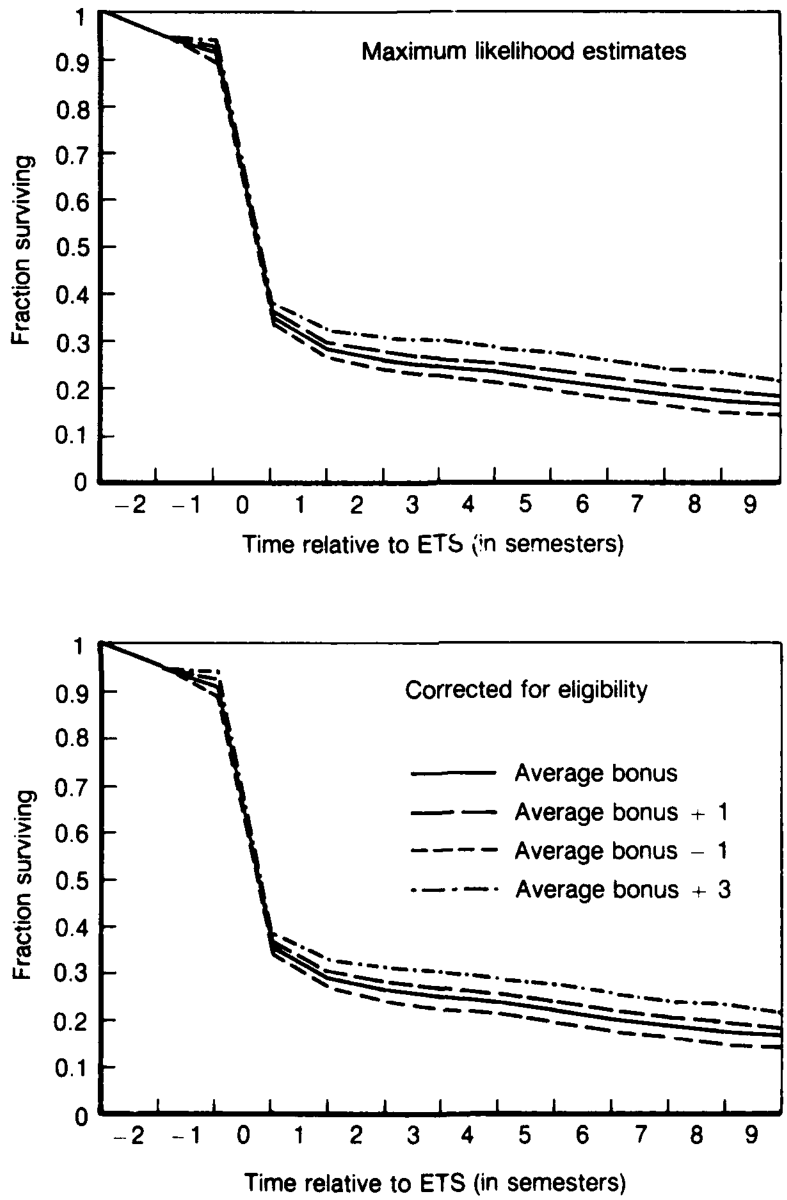


Fig. B.3 –Survivor function PMOS 0811

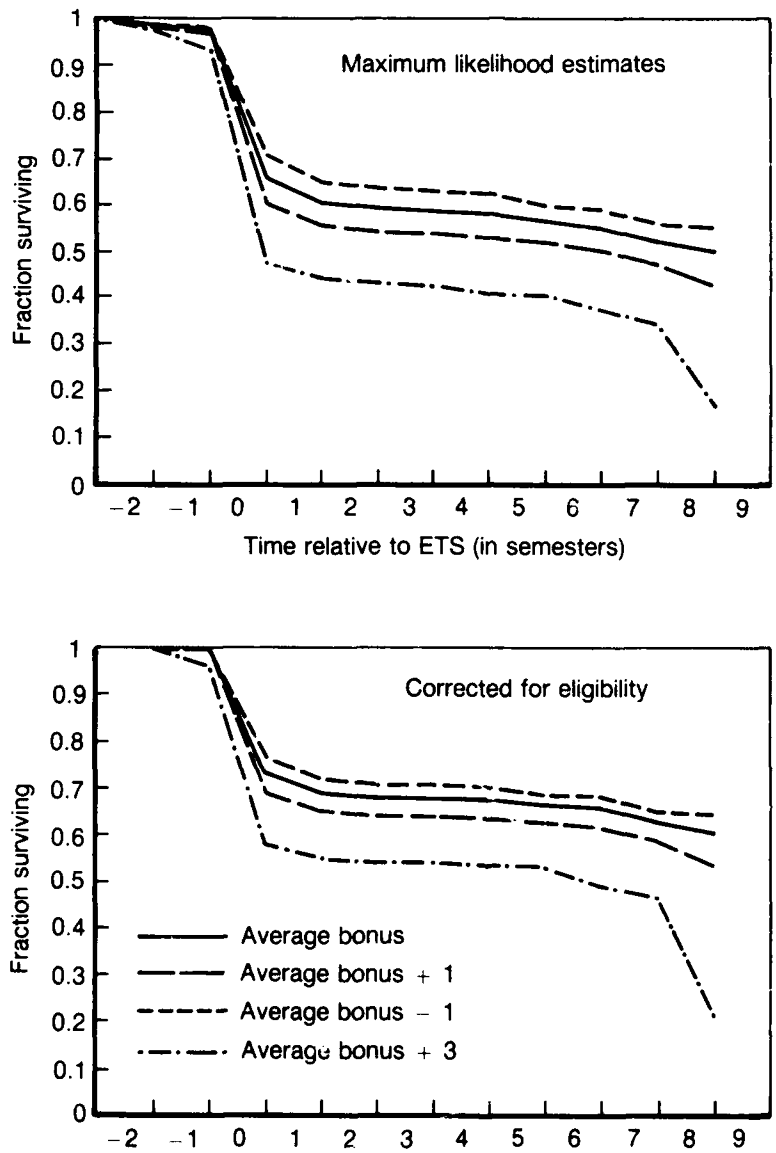


Fig. B.4—Survivor function PMOS 93H

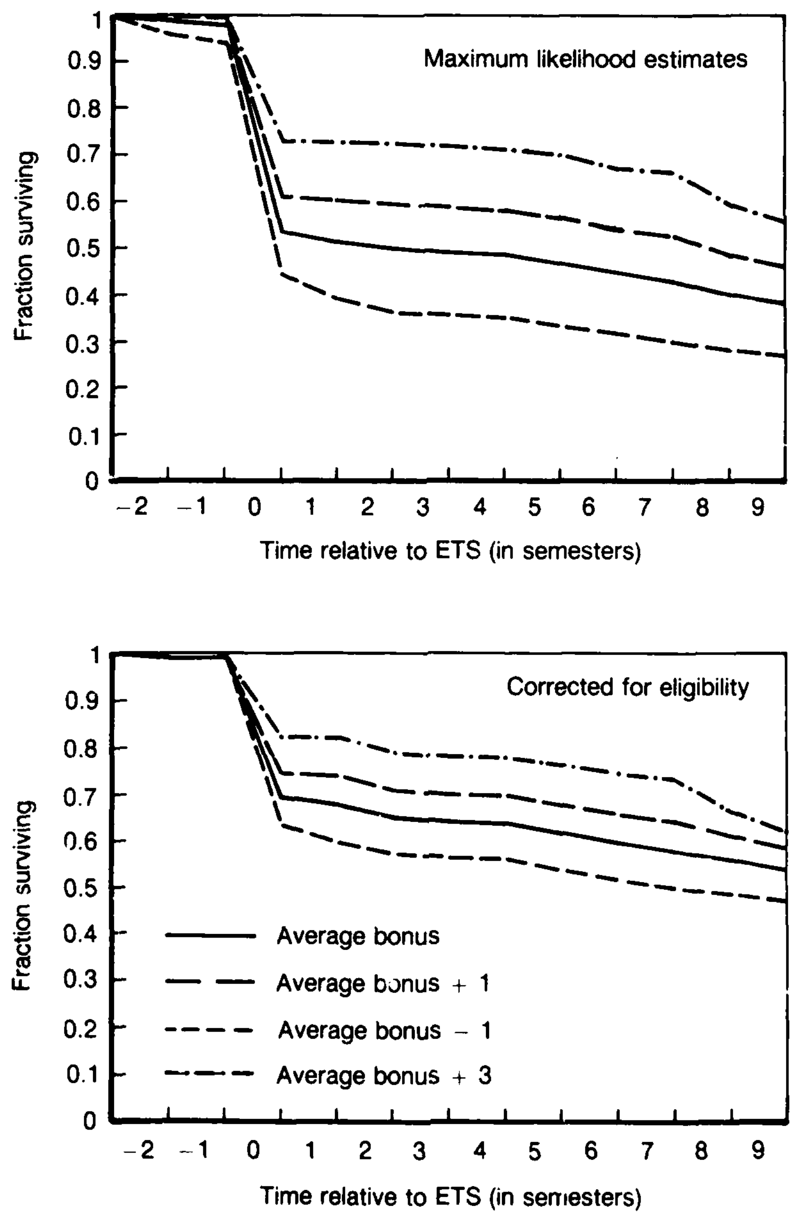
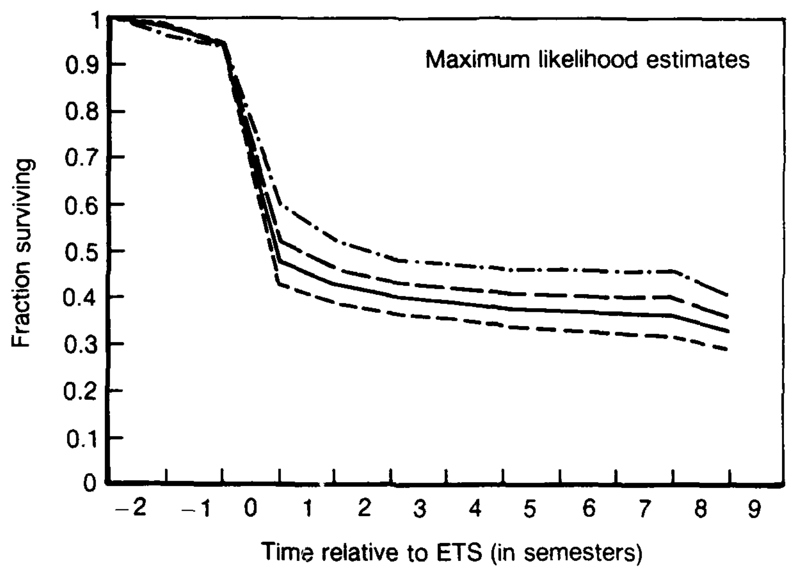


Fig. B.5—Survivor function PMOS 31S



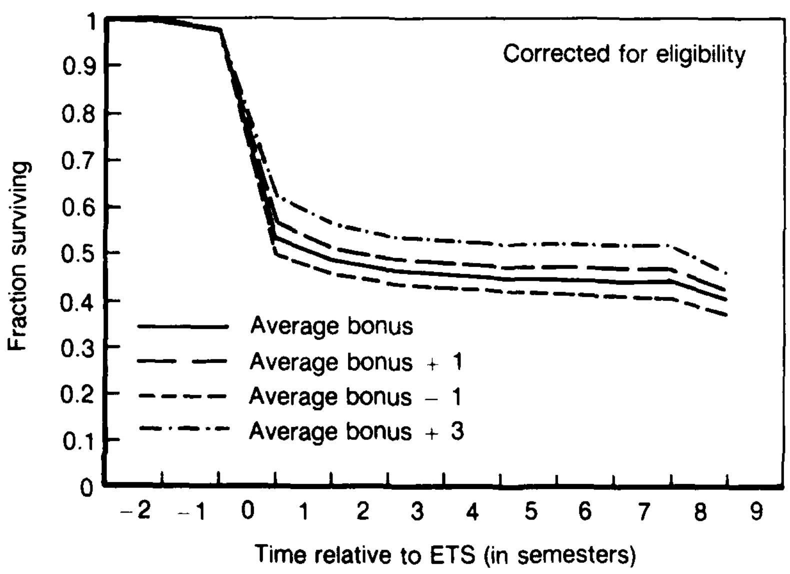


Fig. B.6—Survivor function PMOS AC

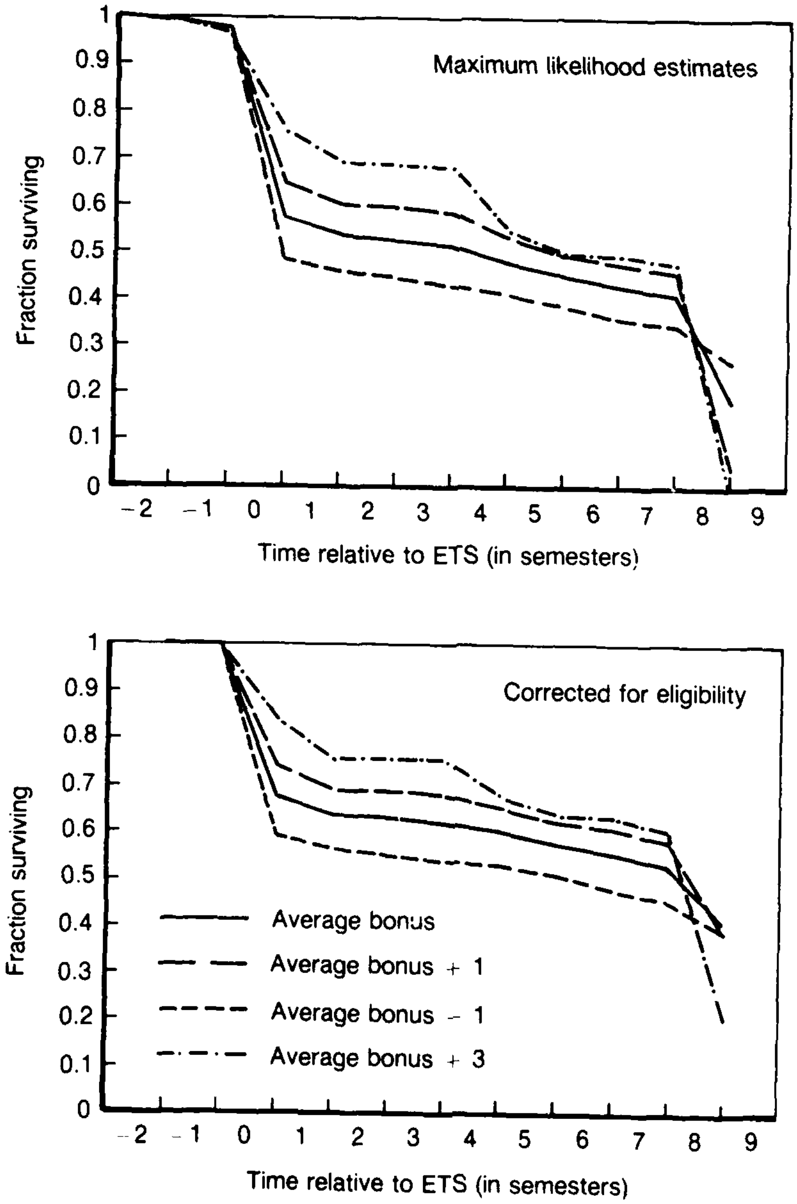


Fig. B.7—Survivor function PMOS 7322

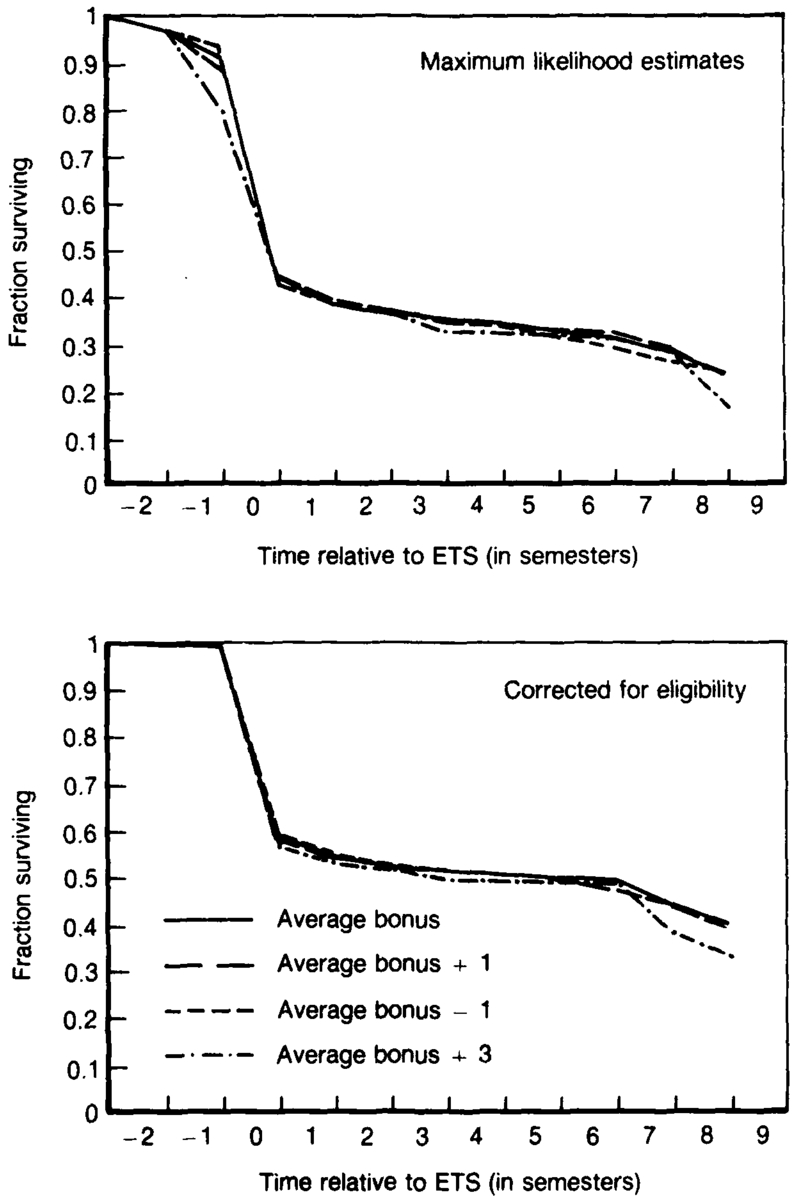
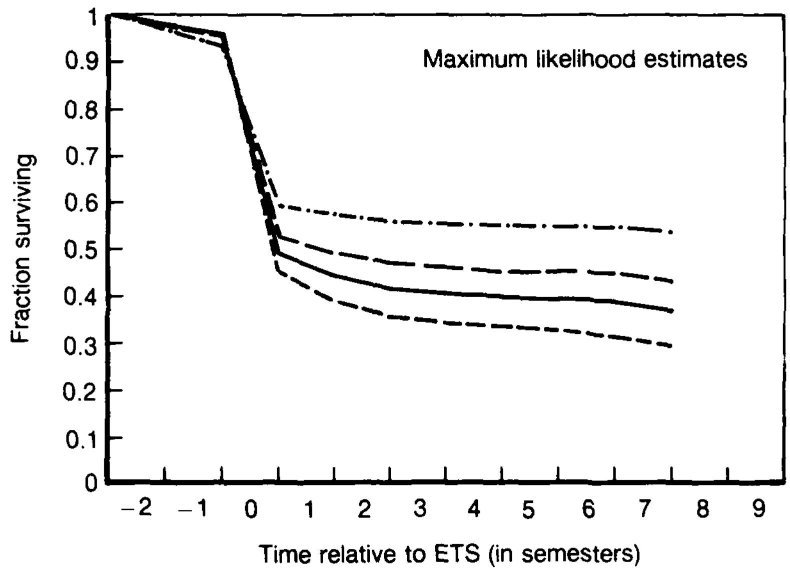


Fig. B.8—Survivor function PMOS 272×0



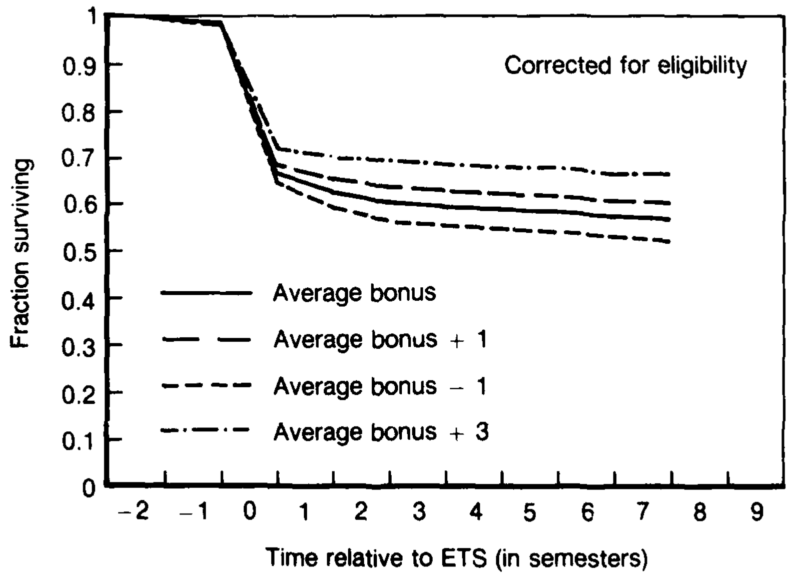


Fig. B.9—Survivor function PMOS 98C

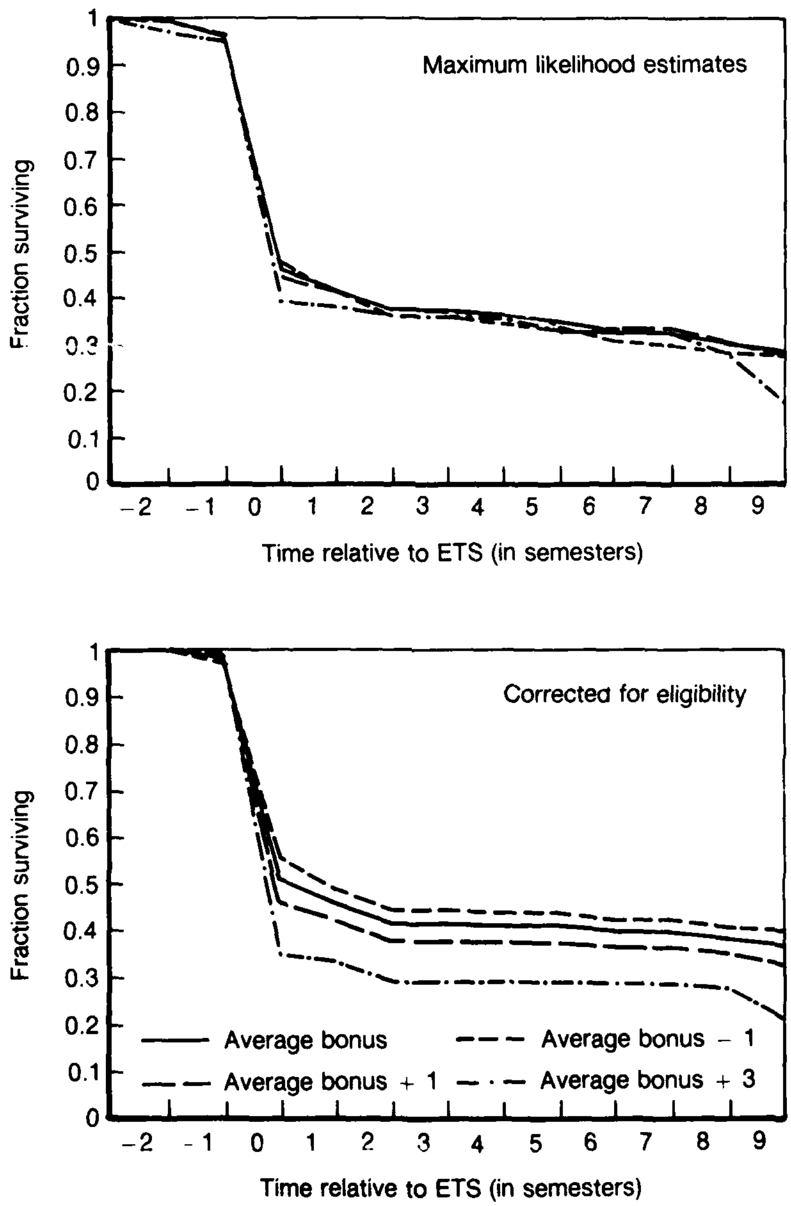


Fig. B.10—Survivor function PMOS CTI

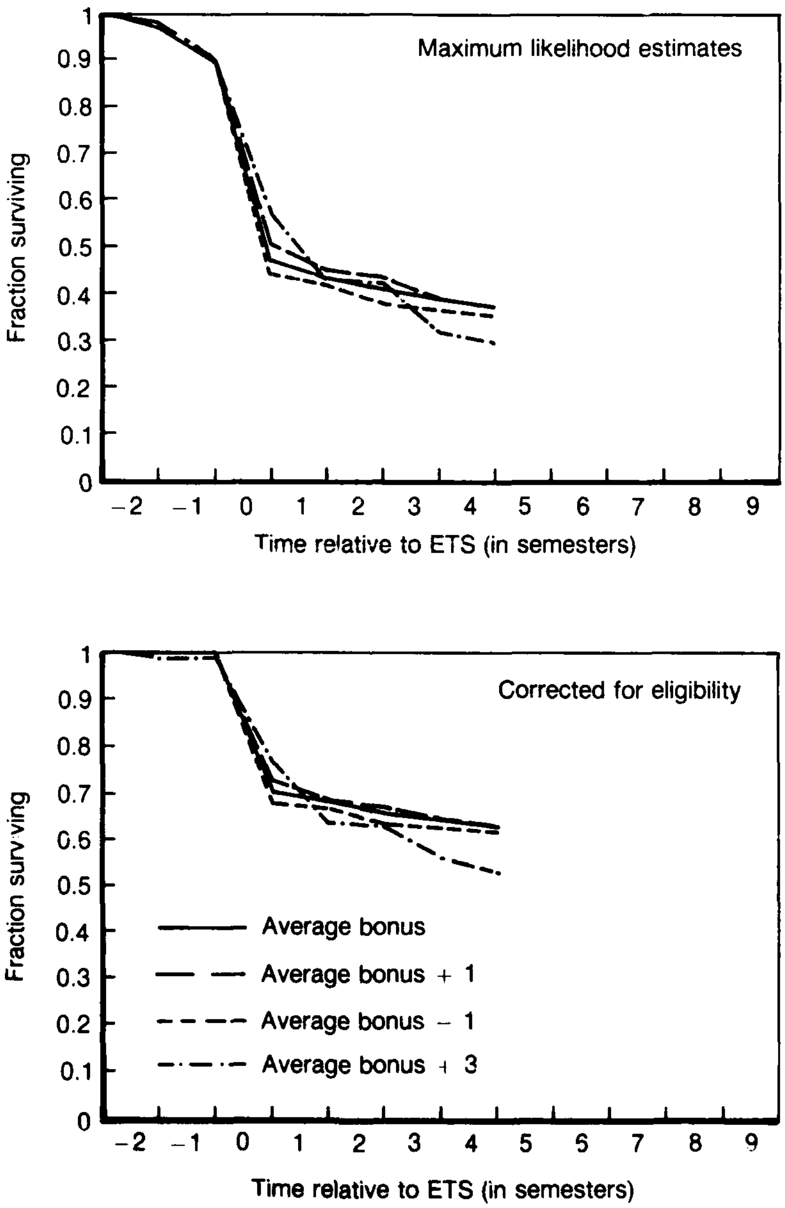
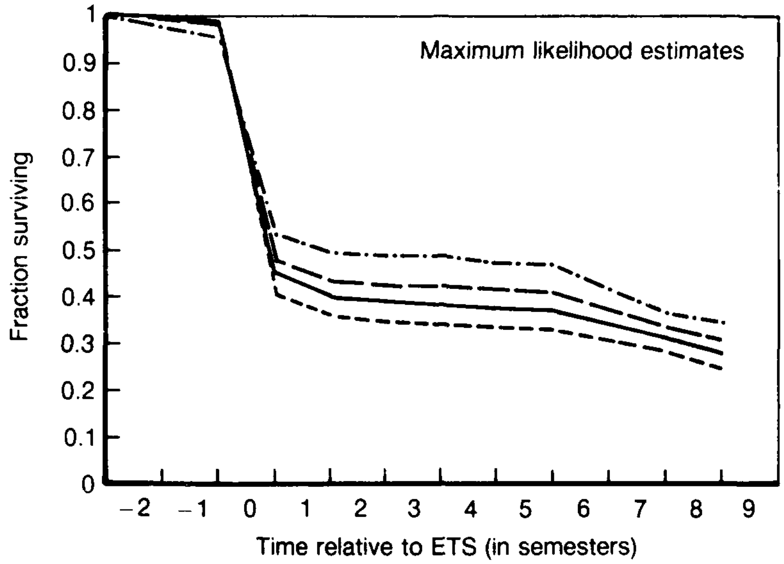


Fig. B.11—Survivor function PMOS 202×0



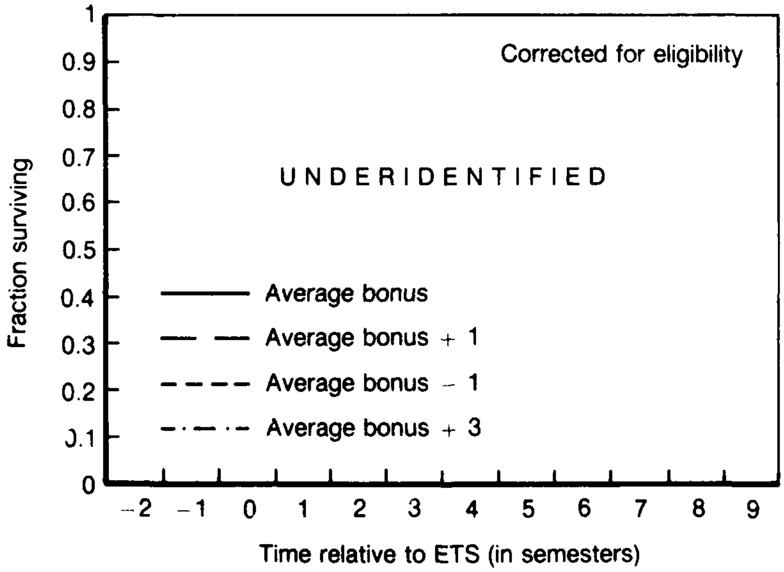
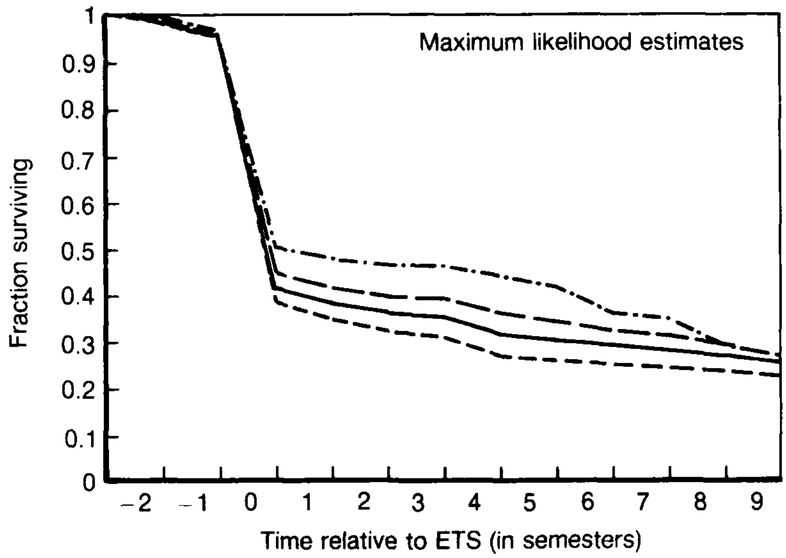


Fig. B.12—Survivor function PMOS 33S



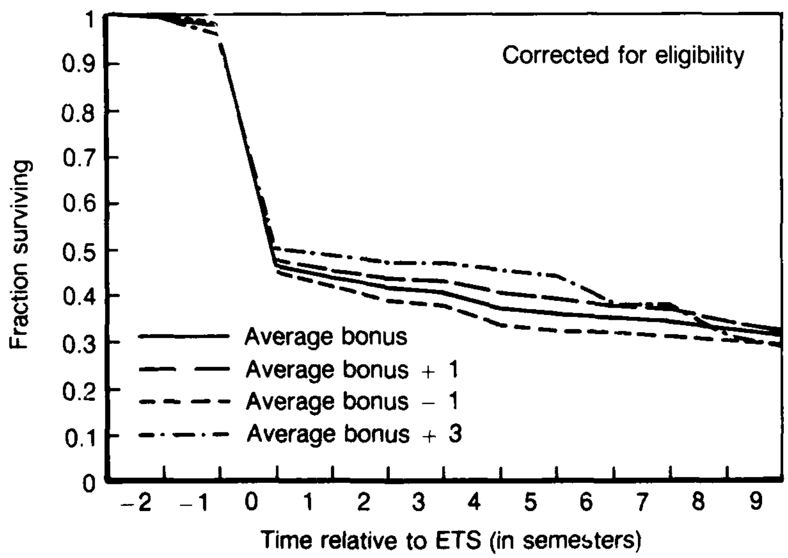


Fig. B.13—Survivor function PMOS AX

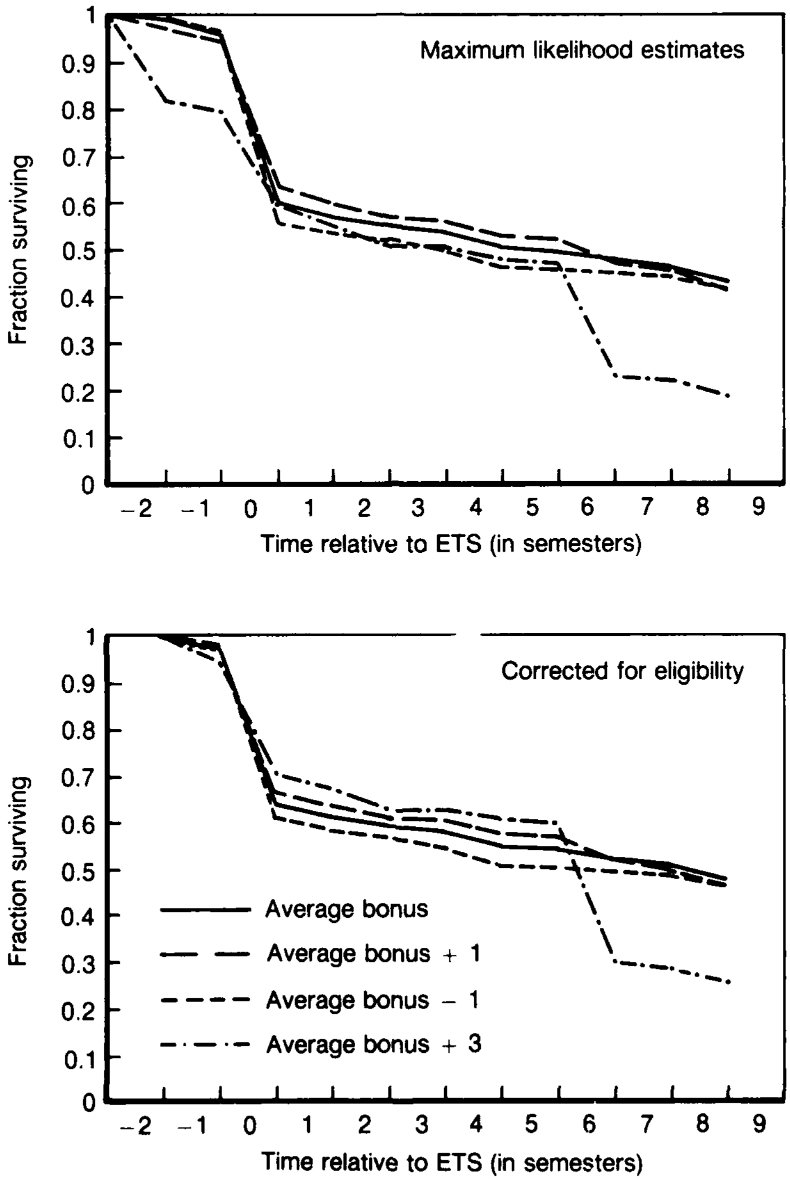


Fig. B.14—Survivor function PMOS CTM

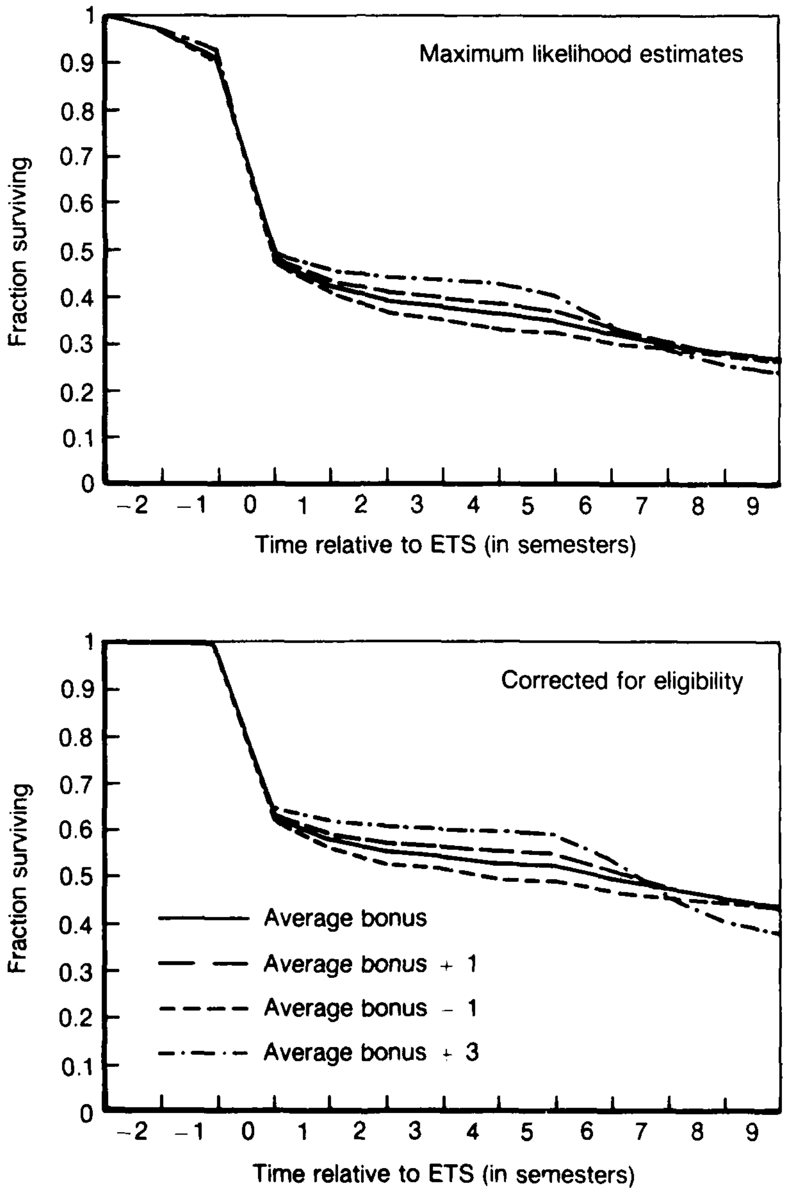


Fig. B.15—Survivor function PMOS AF-COMB

Appendix C

BONUS STEPS IN EFFECT OVER THE OBSERVATION PERIOD

Table C.1

BONUS STEPS IN EFFECT OVER THE OBSERVATION PERIOD

PMOS	Fiscal Half Year Ending													
	7703	7709	7803	7809	7903	7909	8003	8009	8103	8109	8203	8209	8303	8309
Army														
16R	2	2	2	2	0	0	0	0	1	1	1	1	1	1
93H	3	3	2	2	1	1	1	1	1	4	1	1	1	1
31S	0	0	0	0	0	0	0	0	1	1	1	1	1	0
98C	0	0	0	0	2	2	2	2	3	3	3	5	5	5
33S	0	0	0	0	0	2	2	2	4	4	4	5	5	5
Navy														
GMG	3	3	2	2	0	0	0	0	0	0	2	2	1.5	2
AC	2	3	4	4	5	5	5	5	5	5	6	6	4.5	4.5
CTI	2	3	3	3	2	2	2	2	2	2	2	2	1	1
AX	4	4	3	3	1	1	0	0	0	0	3	3	4.5	4.5
CTM	3	4	4	5	4	4	4	4	4	4	4	4	2.5	3
Marines														
0811	2	2	0	0	0	0	0	0	0	0	1	1	0	0
7322	2	3	3	3	3	3	4	4	6	6	6	6	6	5
Air Force														
272×0	3	3	4	4	4	4	4	4	4	4	4	4	4	3
202×0	0	0	0	0	0	0	1	1	2	2	2	2	2	1
304×1	0	0	0	0	0	0	2	2	3	3	3	3	3	2
328×1	0	0	0	0	0	0	0	0	1	1	1	2	2	2
328×3	0	0	0	0	0	0	0	0	0	0	2	3	3	3
328×4	0	0	0	0	0	0	0	0	0	0	2	2	3	3

Appendix D

ALTERNATIVE DERIVATION OF MAN-YEAR EFFECTS

In the text the formula for calculating the additional man-years generated by an SRB step change was derived from the formula for a marginal change in the SRB (Eq. (25)) by correcting the expected man years from each period onward for the compounded effects of changes in prior periods' continuation rates. This appendix provides an alternative derivation based on the definition of expected man-years at two different bonus levels. Only the derivation for the absolute change in man-years (M^*) is shown; the formula for the bonus improvement factor (B) can be derived by analogy.

By definition, the change in expected man-years is given by

$$M^* = \sum_{j=2}^{9} \prod_{i=2}^{j} C_i(1 + b_i) - \sum_{j=2}^{9} \prod_{i=2}^{j} C_i \tag{D.1}$$

where, as usual, C_i is the continuation rate in period i, evaluated at the average bonus step, and $C_i(1 + b_i)$ is the continuation rate in period i, evaluated at a bonus that is one step higher. Regrouping the terms in Eq. (D.1) results in

$$\begin{aligned} M^* &= \sum_{j=2}^{9} \left[\prod_{i=2}^{j} C_i(1 + b_i) - \prod_{i=2}^{j} C_i \right] \\ &= \sum_{j=2}^{9} \left[\prod_{i=2}^{j} C_i \prod_{i=2}^{j} (1 + b_i) - \prod_{i=2}^{j} C_i \right] \\ &= \sum_{j=2}^{9} \prod_{i=2}^{j} C_i \left[\prod_{i=2}^{j} (1 + b_i) - 1 \right] \end{aligned} \tag{D.2}$$

Consider the last term in brackets in Eq. (D.2). It can be decomposed into

$$\left[\prod_{i=2}^{j-1} (1 + b_i) - 1 \right] + b_j \prod_{i=2}^{j-1} (1 + b_i) \tag{D.3}$$

Applying the same decomposition repeatedly to the term in brackets in Eq. (D.3), we obtain by induction

$$\sum_{i=-2}^{j} b_i \prod_{k=-2}^{i-1} (1 + b_k) \tag{D.4}$$

The additional man-years can now be written as

$$M^{*} = \sum_{j=-2}^{9} \prod_{i=-2}^{j} C_i \left[\sum_{h=-2}^{j} b_h \prod_{k=-2}^{h-1} (1 + b_k) \right] \tag{D.5}$$

Writing out this sum yields

$$
\begin{aligned}
M^{*} = {} & C_{-2} \cdot b_{-2} && (j=-2) \\
& + C_{-2} \cdot C_{-1} \left[b_{-2} + b_{-1}(1 + b_{-2}) \right] && (j=-1) \\
& + C_{-2} \cdot C_{-1} \cdot C_0 \left[b_{-2} + b_{-1}(1 + b_{-2}) \right. \\
& \qquad \left. + b_0(1 + b_{-2})(1 + b_{-1}) \right] && (j=0) \\
& \ldots \text{etc.} && \text{(D.6)}
\end{aligned}
$$

Rearranging the terms in Eq. (D.6),

$$
\begin{aligned}
M^{*} = {} & b_{-2} \left[C_{-2} + C_{-2}C_{-1} + C_{-2}C_{-1}C_0 + \ldots \right] \\
& + b_{-1} \left[C_{-2}C_{-1} + C_{-2}C_{-1}C_0 + \ldots \right] (1 + b_{-2}) \\
& + b_0 \left[C_{-2}C_{-1}C_0 + \ldots \right] (1 + b_{-2})(1 + b_{-1}) \\
& \ldots \text{etc.} \\
= {} & \sum_{j=-2}^{9} b_j \left[\sum_{h=j}^{9} \prod_{k=-2}^{h} C_k \right] \prod_{n=-2}^{j-1} (1 + b_n) \qquad \textit{q.e.d.}
\end{aligned}
$$

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